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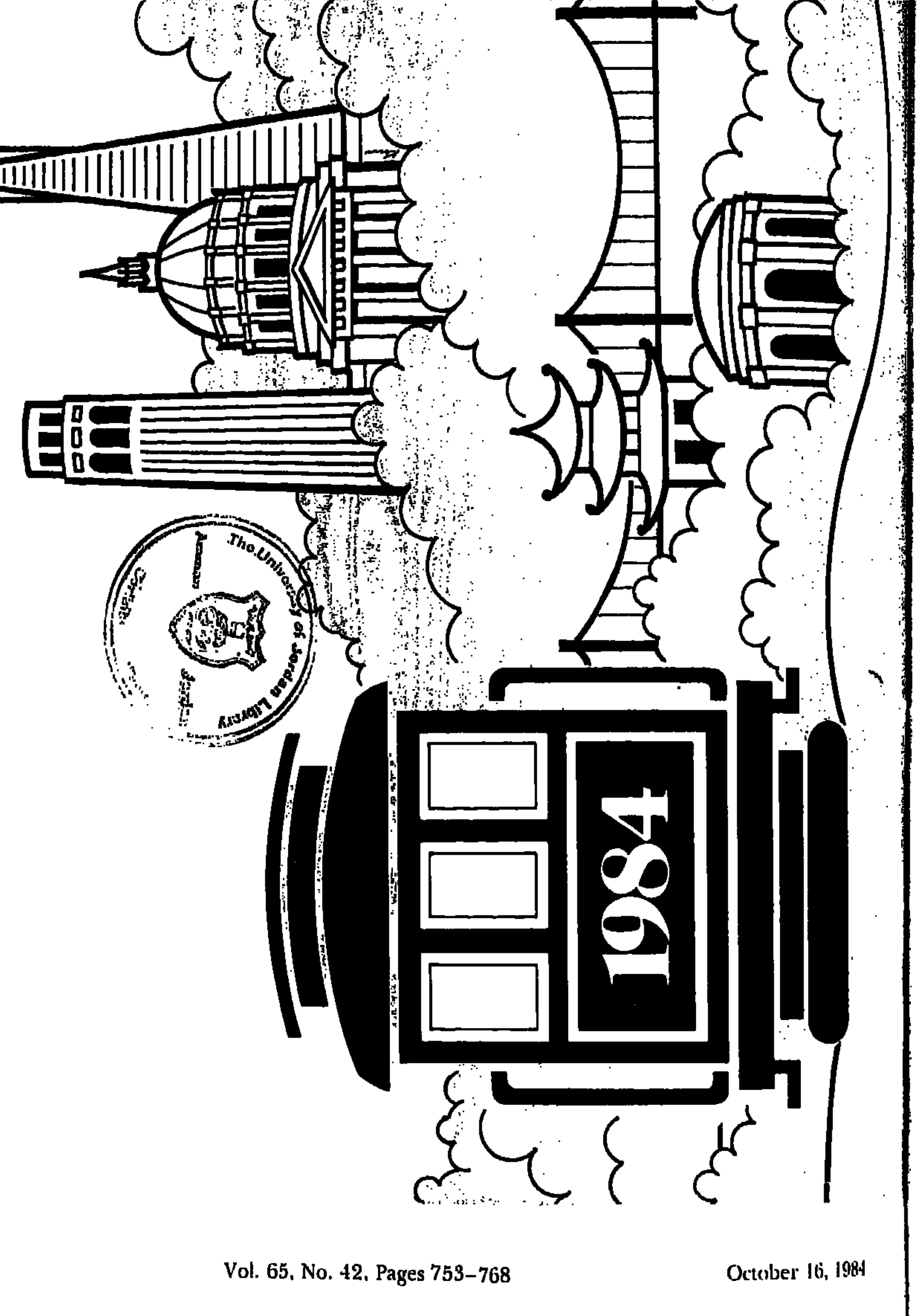

Eos, Transactions, American Geophysical Union Vol. 65, No. 42, Pages 753–768 October 16, 1984

Seismology

6940 Phenomena related to earthquake prediction
FORECAST MODEL FOR MODERATE EARTHQUAKES NEAR PARKFIELD, CALIFORNIA
W. D. Stuart (U.S. Geological Survey, Pasadena, California, 91106), R. J. Archuleta and A. G. Lindh

Earthquake instability models have possible application to earthquake forecasting because the models simulate both pre-seismic and co-seismic changes of fault slip and ground deformation. In the forecast procedure proposed here, repeated measurements of pre-seismic fault slip and ground deformation constrain the values of model parameters. The early part of the model simulation corresponds to the available field data, and the subsequent part constitutes an estimate of future faulting and ground deformation. In particular, the time, location, and size of unstable faulting are estimates of the pending earthquake parameters. The forecast accuracy depends on the model realism and parameter resolution. The forecast procedure is applied to fault creep and trilateration data measured near Parkfield, California, where at least five magnitude 5.5 to 6 earthquakes have occurred regularly since 1881, the last in 1966. The quasistatic model consists of a flat vertical plane embedded in an elastic halfspace. Spatially variable fault slip of strike slip sense is driven by an increasing regional shear stress, but is impeded by a relatively strong patch of brittle, strain softening fault. The field data are consistent with these approximate values of patch parameters: radius of 3 km, patch center 5 km deep and 8 km southeast of the 1966 epicenter, and maximum brittle strength of 26 bars. Fluctuations in the available field data prevent estimating the earthquake time with any more precision than use of the 21 ± 8 year recurrence interval. However, the model may later give a more precise estimate of the earthquake time if the fault slip rate near the inferred patch increases before the earthquake, as predicted by the model.

J. Geophys. Res., B, Paper 4B1214.

6950 Seismic sources (mechanisms, magnitude, frequency spectrum, space, and time distribution)
EXCITATION OF A BURIED MAGMATIC PIPE: A SEISMIC SOURCE MODEL FOR VOLCANIC TREMOR
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Recent observations of seismic events at various volcanoes suggest that harmonic tremor results from the sustained occurrence of so-called long-period events or low-frequency events. Accordingly, we can view the long-period volcanic event as the elementary process of tremor and interpret it as the impulse response of the tremor-generating system. We present a seismic model in which the source of tremor is the acoustic resonance of a fluid-filled volcanic pipe triggered by excess gas pressure. The model consists of three elements, namely a triggering mechanism, a resonator, and a radiator. For simplicity, we assume a hemispherical trigger, cylindrical resonator, and circular radiator, set in a vertical configuration with the trigger capping the top of the pipe and the disk-shaped radiator shutting off its bottom. Considering the simple case of a source buried in a homogeneous half space we then apply the discrete wave-number method to obtain a complete representation of the ground motion response at near and intermediate distances. The results demonstrate that the displacement attributed to the pipe dominated the near-field motion while that due to the disk is representative of the intermediate and far fields. The trigger itself has a smaller contribution mainly limited to the field in the proximity of the source. The characteristics displayed by the free-surface response evolve from a strong impulsive signature in the immediate vicinity of the epicenter to a well-developed harmonic wavetrain dominated by Rayleigh waves at larger distances. No clear shear arrival can be detected in the synthetic seismograms. The displacement spectrum reflects the organ-pipe modes of the conduit, and the bandwidth associated with the dominant spectral peak of motion is controlled by the combined losses due to viscous attenuation in the fluid and elastic radiation into the solid. In the case of the cylindrical magma column considered, the radiation loss is proportional to the square of the pipe radius, while the loss related to viscous damping is inversely proportional to the same factor, indicating that the relative importance of the two loss mechanisms is critically dependent on the geometry of the magma reservoir. The relative importance of the pipe and disk elements, likewise, is a function of the conduit cross-section. This suggests the possibility of determining the geometry of the source, as well as the radiation loss and in-situ magma viscosity from a comparison of near and far field observations.

J. Geophys. Res., B, Paper 4B5125.

6980 Surface Waves
GEOMETRIC EFFECTS OF GLOBAL LATERAL HETEROGENEITY ON LONG PERIOD SURFACE WAVE PROPAGATION
Thorne Lay (Department of Geological Sciences, University of Michigan, Ann Arbor, Michigan 48109) and Hiroo Kanamori

Long period Rayleigh waves from Iranian earthquakes have large amplitude asymmetries between minor-arc and major-arc arrivals (e.g. R_2 and R_3) at digital stations in the azimuth range N20°W to N60°E. These asymmetries are as large as a factor of two at a period of 256 sec, and persist to periods greater than 300 sec. In some cases, the entire Rayleigh wave group arrival spanning periods from 100 to 300 sec is either uniformly enhanced in amplitude or diminished to such a degree that the group arrival appears to be missing. The amplitude anomalies are generally not accompanied by significant phase anomalies. The irregular azimuthal distribution of the amplitude asymmetries, and their occurrence for events with different focal mechanisms and epicentral separations of several hundred kilometers, preclude an explanation of these observations by source complexity. Events in the Mediterranean and Nepal do not produce similar amplitude asymmetries at the same stations. The anomalies are thus most likely due to focusing and defocusing propagation effects. As a preliminary investigation of the effects of lateral heterogeneity of upper mantle velocity structure on long period surface wave amplitudes, surface wave raytracing calculations are performed using recently proposed global phase velocity distributions. Dramatic deviations from great circle paths are predicted for long propagation paths (e.g. R_3). The particular spatial distribution of lateral velocity gradients around a given source location determines whether substantial amplitude asymmetries will be observed between minor-arc and major-arc arrivals, and whether these will persist for sequential great circle orbits. The 200 sec period amplitude asymmetry observed at KIP for the Iranian source region ($R_{2,4}>R_3$) is well-predicted by the raytracing results. The absence of this anomaly for the other source regions is also predicted. Other observed anomalies are not all well-predicted, but it is clear that geometric effects can contribute significantly to the observed variations of Rayleigh and Love wave amplitudes. This is the probable explanation for the instability of Q estimates made from surface waves. Other source regions producing large surface wave amplitude anomalies include Japan and Southeastern Alaska. (Surface waves, lateral heterogeneity, geometric focusing).

J. Geophys. Res., B, Paper 4B5035.

6975 Structure of the earths interior below the upper mantle
THE P WAVE VELOCITY STRUCTURE NEAR THE BASE OF THE MANTLE
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Travel times from 16 events recorded at two [illegible] networks of short-period seismometers deployed across Australia have been used to study the P-wave velocity structure of the mantle below depths of 1700 km. The slowness-distance curves derived from these times show small deviations from the slownesses predicted from the PREM model of Dziewonski and Anderson (1981) that may be significant. The most important feature is a rapid decrease of more than 0.5 s/deg between distances of 87° and 88°. Velocity filtering of seismograms from 5 nuclear explosions in Kazakh recorded at these Australian networks indicates the presence of two arrival branches at distances between 83° and 91° whose slownesses differ by 0.40 to 0.55 s/deg and which intersect at a distance of 87°. Precursors P wave seismograms from the Yellowknife array in Canada also indicate the presence of a similar phenomenon in the same distance range [illegible] two separate regions. The results can be explained by a widespread rapid or sharp increase in velocity of 2.5 to 3.0% about 200 km above the core mantle boundary.

J. Geophys. Res., B, Paper 4B1137

6999 General (Lunar Green Glass)
FORMATION OF APOLLO 15 GREEN GLASS BEADS
J. Arndt (Mineralogisches Institut der Universität Tübingen, 7400 Tübingen, Federal Republic of Germany), W.v. Engelhardt, I. Gonzalez - Cabeza and B. Meier

Size frequency distributions of the cross sections of green glass beads in a thin section of regolith breccia 15427 have been determined. Cross section medians of vitrophyric and glassy beads are 0.22 mm and 0.094 mm, respectively. Vitrophyric beads contain exclusively olivine crystals of three crystallographically different morphologies. With a synthetic melt of green glass composition free flight cooling rates have been determined. Spherules of 0.22 and 0.094 mm in diameter cool at rates of 1500°C/sec and 4200°C/sec, respectively, in the temperature range 1050 - 1000°C. The critical cooling rate for green glass formation, measured under controlled conditions, is about 1°C/sec, indicating that lunar green glass beads cooled in free flight but in a hot gaseous medium. By controlled cooling of synthetic green glass melt droplets from above the liquidus temperature, olivine morphologies have been produced which are identical to those in lunar vitrophyric beads. On the other hand, after heating synthetic glass spherules, textures have been observed which do not occur in lunar green glass. It follows that the lunar [illegible] have been continuously cooled without 'later' heating. It is inferred that green glass melt droplets have been erupted from the lunar interior together with a large mass of gas [illegible] cooling history of which is recorded by the internal textures and the size distributions of the green glass beads.

J. Geophys. Res., B, Paper 4B1824.

Magnetospheric Research and the History of the Solar System

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Instruments in space make it now possible to observe our cosmic environment not only in the visual and radio wavelengths but also in the infrared, ultraviolet X ray and γ ray parts of the electromagnetic spectrum. This reveals that quite a few of the generally accepted astrophysical concepts can no longer be valid. But, in order to understand what we see, it is essential to clarify what laws of physics govern the cosmic phenomena. As (at least by volume) more than 99.99% of the universe consists of plasma, plasma physics is essential. Another and at least as important a change in our basic astrophysical concepts is due to the in situ measurements in the magnetospheres of the planets. These have demonstrated that cosmic plasmas have properties drastically different from those that were rather generally accepted as late as 5 or 10 years ago. These latter were based on the classical theory of plasmas (by Chapman and Cowling and others) which was admirable from a mathematical point of view but unfortunately did not agree very well with experiments and observations. Measurements in the laboratory and in situ measurements by spacecraft have shown that plasma physics must be considered more as an empirical than a purely mathematical science [*Alfvén*, 1981, chap. I and IV, 1982]. In the following we shall follow an essentially empirical approach to certain important astrophysical problems.

Aurora and Cosmic Plasmas

When a cosmic plasma penetrates into the ionosphere, auroras are produced. The aurora is not only one of the most beautiful phenomena in nature; it is also scientifically important because it gives us an understanding of basic properties of cosmic plasmas. When observed locally it is rapidly changing in an erratic way; indeed, often we cannot predict its appearance from one minute to the next. At the same time, its large scale properties are regular: It is essentially confined to the auroral zone, which is governed by the earth's magnetic field; it is associated with an electric current system which produces magnetic storms, etc.

In Situ Measurements

Space research, especially in situ measurements in the magnetospheres and solar wind, has demonstrated that cosmic plasmas basically have the same properties. As most of the universe is filled with plasma, this means that when we observe auroras we may get interesting information about the cosmos in general [see *Alfvén*, 1981, 1982].

Extrapolation in Space and Time

We have now learned how to transfer information, to "translate" plasma phenomena observed in the laboratory to the magnetospheres. There is good reason to continue the translation into still more distant regions, such as interstellar clouds (see Figure 1). This paper discusses how attempts can be made to make a similar translation backward in time: We use our knowledge of present-day plasmas to reconstruct those events 4–5 billion years ago by which the solar system presumably was formed.

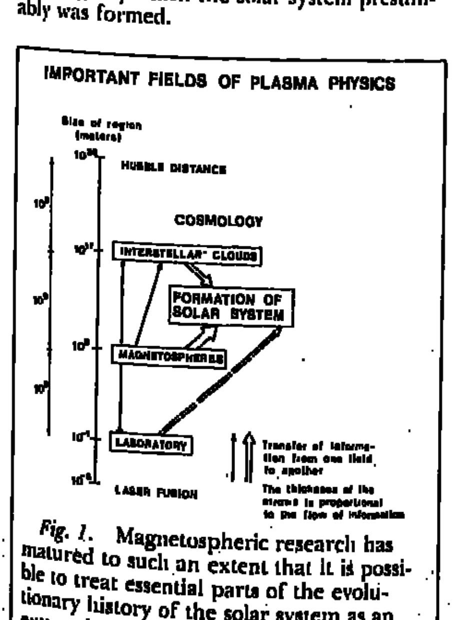

Fig. 1. Magnetospheric research has matured to such an extent that it is possible to treat essential parts of the evolutionary history of the solar system as an extrapolation of magnetospheric research. Laboratory experiments also form an important basis for this. Further, extrapolation from both magnetospheric and laboratory results contributes to a revision of our view of interstellar clouds, and hence influences also the way in which we approach cosmogony. The transfer of information from one field to another is shown in the figure.

Evolution of Interstellar Clouds

It is likely that long before the planets/satellites were formed, the matter they now consist of was part of a dusty interstellar cloud of about the same type as those observed today (Table 1). By extrapolating what we know from magnetospheric studies about the general behavior of plasmas in space (see Figure 1) and combining this with our present increasingly sophisticated observations of interstellar clouds, we have a fair chance of understanding the evolution of such clouds, the formation of stars like the sun, and the formation of a "solar nebula" which surrounded the proto-sun. (The scenario will be rather different from what has been generally believed before the new phase in cosmic plasma physics.) This evolution was governed by a combination of mechanical and electromagnetic forces [*Alfvén*, 1981, chap. IV]. It is essential to include the physics of dusty plasmas in such considerations.

Evolution of the Solar Nebula

Similar considerations hold for the first phase of the evolution of the solar nebula up to a very important event, viz., the transition from plasma to "planetesimals." By planetesimals we mean small bodies like asteroids of widely different sizes (microns to millimeters, meters, kilometers, or megameters), which are formed from the dusty plasma. The planetesimals later aggregate to planets. This evolution is ruled exclusively by mechanical forces (cf. Table 1).

One of the processes dominating this evolution of the plasma phase was the transfer of parts of the solar angular momentum to the surrounding plasma which was brought into a state of partial corotation. In this state, two-thirds of the solar gravitation was balanced by the orbital centrifugal force and one-third by electromagnetic forces. For the theory of this see *Alfvén and Arrhenius* [1975 pp. 151 and 164, 1976, chap. 17, 18]. The factor 2:3 derives from the geometry of a magnetic dipole field.

The Two-Thirds Contraction

At the plasma-planetesimal transition, the electromagnetic forces vanished because the charge of the planetesimals was negligible. As the centrifugal force was insufficient to keep the plasma in equilibrium with gravitation the result was a contraction by a factor 2:3. When later some planets produced satellites, a similar process took place; for example, around Saturn.

From the chemical and dynamical properties of the planetesimals it is possible to reconstruct some of the properties of the plasma state before the transition. If, later, the planetesimals aggregate to planets or satellites much of the stored information is lost.

The Plasma-Planetesimal Transition

The plasma-planetesimal transition was not one event which took place at a certain instant; it was a series of small-scale transitions. Each transition was a rather rapid and irregular process, like an aurora. But a long sequence of such processes over millions of years gave a highly regular result—like the secular regularity of the aurora—and for the same reason: It was largely regulated by the magnetic field.

TABLE 1: Formation of Planets/Satellites From Interstellar Clouds

State of matter which is located at present in planets/satellites	Evolutionary Process	Main Evolutionary Mechanism
	Evolution of Interstellar Cloud Formation of Sun and Solar Nebula	Gravitation Pinch Effect
Dusty Plasma	Evolution of Solar Nebula	Electro-Magnetic Transfer of Angular Momentum; Critical Velocity
	Plasma-Planetesimal transition	2/3 Contraction Cosmogonic Shadow Effect Rosseland Field
Planetesimals	Accretion of Planetesimals to Planets	Mechanical Effects Plasma Processes not Important
Planets		
Satellites	Formation of Satellites around Planets occurs by a Repetition in Miniature of these Processes (starting with formation of nebula around planet).	

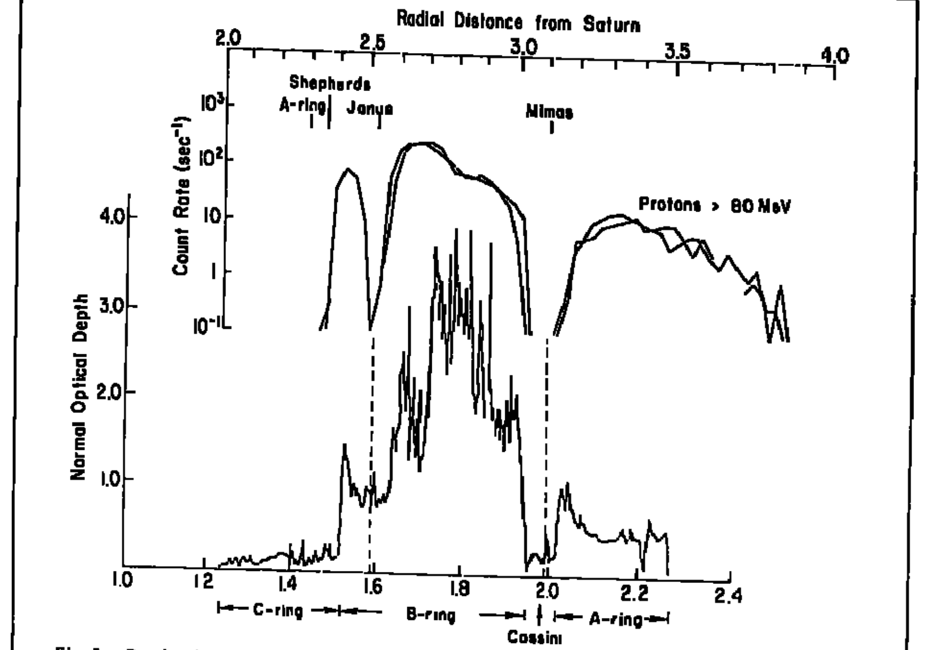

Fig. 2. Production of cosmogonic shadows: Top curve is an example [*Fillius and McIlwain*, 1980] of how under present conditions Saturnian satellites may carve "holes" in the plasma around Saturn. We compare this with the density profile of the Saturnian ring shown by the bottom curve (from *Holberg* [1982, personal communication 1983]; compare *Esposito et al.* [1983]). Extrapolating to cosmogonic conditions, we assume that analogous phenomena produced similar holes. Shrinking the distances by 2:3, we can explain the Cassini division as the "cosmogonic shadow" of Mimas, the minimum at 1.58 as the shadow of Janus (because of insufficient contrast not clearly visible in the photograph in Figure 3), the cut off between B and C rings as the shadow of the shepherds and the A ring, and the inner border of the C ring as the shadow of the outer limit of the B ring. Compare Table 1 and also the list of references.

Information Stored in the Saturnian Rings and the Asteroidal Belt

Surprisingly enough, it seems that it is possible to give a rather detailed reconstruction of events during an early phase of the evolutionary history of the system. The reason for this is the high degree of dynamic stability of a population of small bodies in Kepler orbits. As has been shown by *Baxter and Thompson* [1971, 1973] and by *Lin and Bodenheimer* [1981] collisions between particles in Kepler orbits do not give an ordinary diffusion (tending to smooth out the particle distribution), but cause a negative diffusion. This means that collisions make the particle orbits more similar so that a large number of stable circular rings are formed. The fact that the Saturnian rings consist of 10,000 if not 100,000 separate ringlets confirms the theory.

Hence, the present bulk structure of the Saturnian ring may very well have been formed at the plasma-planetesimal transition 4–5 billion years ago.

Moreover, as the Saturnian ring is located inside the Roche limit, tidal effects from Saturn prevent the planetesimals from accreting to satellites so that the direct product of the plasma-planetesimal transition is stored in the rings.

Another similar case is the asteroidal belt, where the density is extremely low, with the result that the formation of a planet (or several planets) is still in an early phase. These two specimens of the planetesimal phase are crucial to our attempts to reconstruct the evolutionary history of the solar system, because they give detailed information of the plasma-planetesimal transition (compare Table 1 and *Alfvén and Arrhenius* [1975, 1976]).

We know from observations of the Jovian and Saturnian magnetospheres that satellites carve "holes" (actually produce toroidal empty regions) in the plasma (see top curve in Figure 2). If such a process was active already at cosmogonic times, we should expect that, for example, the satellites of Saturn should absorb plasma. After the 2:3 contraction, the hole should be found as a "cosmogonic shadow" at 2:3 of the present-day distance of the satellites.

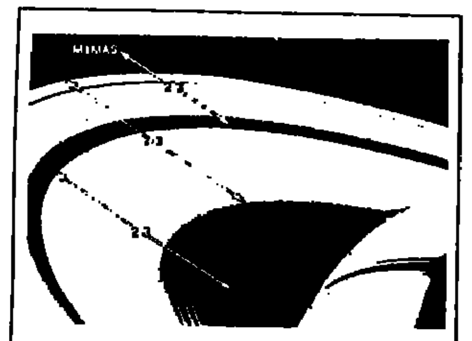

Fig. 3. Photograph of the Saturnian ring showing some of the "cosmogonic shadows." Such shadow effects explain the bulk structure of the ring system.

Figure 2, lower curve, shows that at 2:3 of the distance of Mimas we find Cassini's division, the most pronounced dark region in the ring (see Figures 2 and 3). Further, at 2:3 the distance of "Janus" (the co-orbital satellites), we find a minimum which, in the density curves (Figure 2), is very pronounced but (because of insufficient contrast) is not always clearly visible in photographs (Figure 3). A further comparison shows cosmogonic shadows, characterized by a 2:3 contraction, in four cases in the Saturnian ring (see Table 2). A similar study of the asteroidal belt shows three similar cases of "shadow" effects, so we have no less than seven cases which clearly show the cosmogonic shadow effect (see Table 2). Comparing the observed contraction ratio with that which is theoretically predicted we find an agreement within a few percent. For details see *Alfvén* [1983, 1984].

Article (cont. on p. 770)

Article *(cont. from p. 769)*

TABLE 2: Cosmogonic Shadows

Saturnian ring from Holberg's data	a	r
Mimas	3.075	
		0.646
Co-orbitals	2.510	
Shepherds	2.349	
	2.310	0.63
Cassini Center	1.984	
Outer B	1.945	
		0.655 (0.650–0.660)
Holberg min	1.58	
Inner B	1.525	0.635
Inner C	1.235	

Average 0.642 ± 2% (Theoretically, a 4% correction should be applied to the contraction ratio 2:3)

Asteroidal region		
Jupiter	5.18	
		0.676
Main belt outer limit	3.50	
		0.674
High density outer limit	3.22	
		0.683
High density inner limit	2.36	
Main belt inner limit	2.20	
Theoretical value		0.667

(Alfvén, 1981b)

Cosmogonic Geology

A further analysis demonstrates that this means that we can reconstruct, with remarkably high accuracy, physical processes at the plasma-planetesimal transition, which must have taken place 4–5 billion years ago. In other words, the Saturnian ring should be considered as a fossil from cosmogonic times which is preserved because in the ring the diffusion is negative.

Geologists can reconstruct early events by a study of an ancient rock structure. Similarly, we can use Saturnian ring information to reconstruct parts of the evolutionary history of the Saturnian system. The asteroidal belt is a similar fossil from which we can get essential information about the early state of the planetary system.

Conclusion

What has been said above has far-reaching consequences for our understanding of the evolutionary history of the solar system. We shall only mention a few of them: (1) the formation of the planetary system and the formation of the satellite systems were basically similar processes; (2) the evolution of an interstellar cloud to the present planets/satellites was governed by electromagnetic and mechanical effects up to the plasma-planetesimal transition and later exclusively by mechanical effects; (3) the formative plasma processes were similar to the auroral processes in the sense that they consisted of a long series of apparently erratic local phenomena which, however, followed certain large-scale patterns, leading to an integrated result of a smooth buildup of the present structure of the solar system, and there is no evidence for large-scale turbulence or dramatic processes (as has been assumed in pre-space-age theories); (4) a further development of this approach can be expected to lead to a more detailed theory of the formation of planets and satellites and, hence, connect with geology, paleobiology, and related sciences; and (5) extrapolation backward in time will give us important information about the structure of the solar nebula and the formation of the sun and, hence, connect with galactic astronomy in general; further, the possibility of an accurate determination of 4–5 billion year old events will give us information of cosmological significance (e.g., to what extent, if any, the physical constants have varied).

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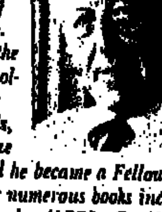

Forum

Implementing the Peer Review Process in AGU Publications

Recently, *Russell and Reiff* [1984] presented a flow-diagram analysis of the AGU publication process indicating how publication delays naturally occur. Perhaps because of space limitations, their diagram did not include some important control statements. For example, according to their diagram, all manuscripts are either published or enter an endless loop. In fact, many papers end up elsewhere: As fish wrappers, in filing cabinets, or in non-AGU publications. (Accepted papers can end up in the same places, but they have the advantage of having been published in an AGU journal.) Significantly, the number of times the paper passes through the submission-refereeing loop (N_j) is not just journal dependent. N_j also depends inversely on η_D, the density of Dogma in the paper. We are concerned with the publication process also and are motivated by reports that N_j is unusually large in the case of certain distinguished colleagues, particularly when introducing new concepts or criticizing older approaches. Some suggestions are offered here to speed publication and consequently to assist in the smoother functioning of the scientific method in geophysics.

History provides numerous examples of the difficulty in publication of new ideas for example in astronomy [*Opik*, 1977], magnetic reconnection [*Dungey*, 1983], and field-aligned currents [*Dessler*, 1984]. *Oppenheimer* [1955] was well aware of such problems and reminded us of the need for moderation in his monograph *The Open Mind*:

> Science is novelty and change. When it closes, it dies. All history teaches us that these questions that we think the pressing ones will be transmuted before they are answered, that they will be replaced by others, and that the very process of discovery will shatter the concepts that we today use to describe our puzzlement.

Such an open-minded attitude seems to have been implemented in a practical way and to a surprising degree by *Dessler* [1972] in his tenure as editor of the space physics section of the *Journal of Geophysical Research* (JGR). *Dessler* [1972] felt that authors had a right to publish their work so long as it met standards of relevance, clarity, and brevity: "The authors, on the other hand, do have a right to publish their work. Their reputations as scientists, and hence their careers, are strongly affected both by their ability to publish and by the quality of their published work. Therefore, I feel it is important to somehow maintain the journal's standards without harassing the authors." Dessler warned that "Unless the editor resolves to keep the journal an open forum, it will tend toward publication of ideas that are judged by the referees to be 'safe.'"

Dessler resolved not to limit publication to ideas that "pleased the referees or that fell in with the majority opinion." Dessler frequently accepted well-written papers that infuriated some referees and welcomed the controversy and comments that naturally ensued. He often used only one referee to speed the review process. Most significantly, Dessler never asked the referee for his opinion as to whether or not the paper should be published. Dessler asked the referee four questions which I have paraphrased: Is the paper well written? Does it contain new material? Is proper credit given to related work? Is the abstract appropriate?

By contrast, a referee for JGR-A is now asked first whether a paper is fully acceptable, basically acceptable with minor revision, basically acceptable but requires important revision, may be acceptable after major revision, or is unacceptable. "Acceptability" is nowhere defined. It might be related to the Information For Reviewers, which appears on the reverse side of the Review Form. The Information for Reviewers contains guides for the completion of a written review and includes Dessler's four questions as well as seven others. The referee is asked to determine whether the research is "scientifically sound," is presented in a "responsible manner," and is told to note that the paper "need not agree... with your own view in order to be publishable." Assuming that the referee has read these instructions, one wonders how many referees can find "acceptable" views with which they cannot agree. Also, how often are scientific dogmas ever found unsound or irresponsible?

Under Dessler's editorship, in cases where a distinguished senior author submitted a paper it was usually reviewed by a graduate student because "the graduate student's advice could be easily ignored while the report of a senior referee could not. Only one paper by a distinguished author was ever finally rejected for publication." Thus it is clear that Dessler used the peer review procedure only as an advisory tool and not as the final determinant of what should be published. No referee can determine with certainty (on a scientific basis) what new idea will prevail in decades to come. Thus it is not in the best interest of science to give referees the power to make such a determination.

I have proposed to limit referee power by allowing an author to publish a disputed paper after he has heard the referee charges against it. At the same time, I have also proposed allowing the referee to publish his criticism of that paper. This proposal seems closely related to Dessler's procedure which led to rapid development of space physics and encouraged scientists to communicate in AGU publications.

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Referees and Controversy

P. J. Baum has broadened the discussion of the peer review process, particularly as it pertains to the space physics section of the *Journal of Geophysical Research* (JGR-A). The primary point raised by Baum is that the referees tend to be cautious with regard to the introduction of new ideas or ideas with which they do not agree. When asked to decide whether or not a paper should be published (rather than the decision being made alone and unambiguously by the journal Editor), referees tend to recommend against publication of papers they do not feel are both sound and safe.

This attitude on the part of the referees is, I feel, exacerbated by the present practice in JGR-A of identifying the referees at the end of the paper: "The Editor thanks referee A and referee B for their assistance in evaluating this paper." The advantage of this practice is clear: the referees are rewarded for their efforts by seeing their names in print and therefore are motivated to do a conscientious job when asked to review a paper. However, this practice has its negative aspects. By identifying the referees at the end of the paper, their status has been elevated nearly to that of a junior author or a junior editor. If a referee receives a paper whose author is marching to the sound of a different drummer, would he be willing to recommend it for publication, have his name placed at the end of the paper identifying him as a referee, and then listen to his colleagues say something like, "Why in the world did you ever let them publish that paper?" Instead, the referee of a controversial paper is most likely to recommend rejection. After several cycles of revision and rejection, the referee may finally give up and, in exasperation, ask that the Editor not reveal his name at the end of the paper. Thus, the present practice of JGR-A of identifying referees strengthens the natural inclination of referees to reject papers with which they personally disagree or that do not appear safe. I believe the practice of identifying referees should be discontinued.

I would also like to suggest a slight variant to Baum's suggestion that a controversial but clear paper be published and the referee be allowed to publish his criticism of it. Something like this was done in the late 1960's as can be seen by picking up almost any issue of JGR-A from that period. Once a paper was published, it was open to critical comment. Hardly an issue came out during my final years as Editor that did not have one or two critical comments on some earlier paper. Criticism thus went beyond publishing the criticisms of the referees. Critical comments were immediately accepted for publication and transmitted to the author of the paper being criticized to see if he wished to write a response. If the author replied, his reply was transmitted to the critic to see if he wished to revise his comments. No refereeing was involved at any stage. After a few rounds in private, a concise statement of criticism and defense was at hand, the ensuing comment and reply were published, and the matter was regarded as closed. Running controversy was not allowed. I felt that this part of the journal was one of the most entertaining, and it certainly enlivened the journal and contributed to the maintenance of high standards for publication.

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News

Passive French Drain

Major environmental concerns of the low-level radioactive waste management operations at Oak Ridge National Laboratory (ORNL) are that the groundwater in this location is near the soil surface and that there is a possibility of water infiltrating the disposal trenches at old solid waste storage areas (SWSA's). In the current SWSA (SWSA 6), a group of trenches (49-Trench area) collect and hold water with seasonal fluctuations ranging from 1 to 2 m. This seasonal wetting of the buried waste has resulted in the movement of ^{90}Sr to a surface stream within the disposal area. To reduce infiltration and prevent waste leaching, the entire 0.44-ha 49-Trench area was sealed with a bentonite clay cover in October 1976. Subsequent monitoring indicated that the cover had not corrected the trench water problem, which suggested a faulty seal, an alternate recharge source, or both.

To improve isolation of the 49-Trench area from shallow subsurface flow originating in upgradient recharge areas, and to suppress the fluctuating groundwater, a French drain engineered barrier (see cover, this issue) was constructed in September 1983. The drain was installed in two sections having a design width, total length, and depth of 1 m, 252 m, and 9 m, respectively, and an expected water table drawdown of 2 to 3 m at the deepest point. Discharge for each section of the drain enters small ephemeral streams which drain surface water from the site. The drain was excavated, lined with filter fabric, backfilled with crushed stone, and covered with a 0.6-m layer of excavated material in 17 days at a total cost of $153,000 ($600/m of drain). Post-construction water level monitoring in wells throughout the 49-Trench area indicates that the drain has suppressed the groundwater to a level below the bottoms of the waste trenches (4.9 m) over approximately 50% of the disposal site (within a 60-m distance of the drain). In addition, five trenches have been completely dewatered and no longer become saturated during periods of heavy rainfall.

From an economic standpoint the passive French drain was judged to offer considerable cost savings over other remedial actions considered for the site (for comparison, rock-filled caissons, $682,000; slurry wall, $168,000; buried waste, $1,000,000). The drain requires no operation or maintenance costs, has achieved a maximum groundwater drawdown of 4 m in the northeast corner of the site where the two sections of the drain intersect, and shows promise as a future site stabilization technique for problem trenches in ORNL's solid waste disposal areas.

ORNL is operated by Martin Marietta Energy Systems, Inc., under contract DE-AC05-840R21400 with the U.S. Department of Energy.

This news item was contributed by E. C. Davis *and* R. G. Stansfield *of the Environmental Sciences Division of Oak Ridge National Laboratory, Oak Ridge, Tenn.*

EOS

Transactions, American Geophysical Union

The Weekly Newspaper of Geophysics

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Cover. A passive French drain (see news item, this issue) has been installed at an Oak Ridge National Laboratory low-level radioactive waste disposal site to suppress the fluctuating water table. In the background of this photograph of the open drain, the filter fabric, monitoring wells, and crushed stone backfill can be seen during installation. In the foreground, photographs of the 9 m deep trench are being taken with a remote-controlled camera to study the shallow geologic structure along the 252-m excavation. (This photo was contributed by E. C. Davis, Research Staff Member, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831.)

Continental Drilling

The National Science Foundation (NSF) now is considering a proposal to begin initial studies on a 10-km drill hole, deeper than any drilled in the United States to date, to be located in the southern Appalachians. Earlier this year a National Research Council (NRC) committee recommended that this area—a thin-crust overthrust region—should be a first priority if and when monies are made available for deep drilling projects.

If NSF accepts the proposal, funding, reportedly $2 million, will be made available to pinpoint the specific drill location and to develop the necessary base of regional information needed to conduct the drilling operations and scientific investigations. NSF is expected to reach a decision soon.

According to NSF, this proposal is but one of some $20 million worth of proposals submitted for deep drill projects. NSF currently has been allocated approximately $7 million in fiscal year 1985 for deep drill activities under the Continental Lithosphere program in NSF's earth sciences division. Leonard Johnson was recently appointed director of that program.

Although the concept for such a program was first developed in the early 1960's, this first deep drill project could be the beginning of what is envisioned as a long-term national program of continental research drilling to answer basic scientific questions. NSF would be the lead agency responsible for overall management, while two other departments, the Department of Energy (DOE) and the U.S. Geological Survey (USGS), would also share responsibility. The three agencies formalized their cooperation on April 2 when they signed an interagency accord (*Eos*, May 22, 1984, p. 361). DOE has already conducted several drilling projects through its Office of Basic Energy Sciences. In September, DOE completed a well at Long Valley Caldera, California, drilling to a depth of 856 m (*Eos*, September 25, 1984, p. 721).

Support in Washington for a national drilling program appears to be running at an all-time high. The White House Office of Science and Technology Policy (OSTP) has recently given the concept its endorsement and was instrumental in planting the seed money at NSF to begin preparatory studies. More recently, the Senate showed its support in the form of Senate Resolution 439, passed in the early morning hours of October 3 in the Senate's scramble to adjourn. In the resolution (see box), nine Republican and two Democratic senators—led by Senator Larry Pressler (R-South Dakota)—expressed their approval of a national program of scientific continental drilling. In an unusual move, George Keyworth, science advisor to President Ronald Reagan and director of OSTP, responded to the resolution with a personal statement of support. On October 10 the House of Representatives passed a similar resolution as an amendment to the Interior Department appropriations bill; this bill was signed into law by the President on October 12.

The impetus to begin deep drilling activities in the Appalachians is based largely on a report of NRC's Continental Scientific Drilling Committee (CSDC), which gave highest priority to drilling in the overthrust area of the southern Appalachians, a geologic area which extends through the Carolinas, Georgia, and Alabama. Given funding, according to CSDC, this drilling program could get underway in FY 85 with drilling operations beginning in FY 1986. A preliminary study suggested that it would take up to 3 years at a cost of $40 million for drilling alone. Scientific activities could add an additional $20 million.

According to the CSDC report "Priorities for a National Program of Continental Drilling for Scientific Purposes," the major objective of the Appalachian drill will be to evaluate and verify the current model of overthrusting tectonics. A better understanding of the thrusting mechanism could be obtained by actually drilling through the thrust sheets. If the sedimentary or metasedimentary Paleozoic rocks found below the thrust sheets are of the same type found to the west beyond the sheets, then the thrusting hypothesis will have been verified.

Samples will be taken of the overthrust sheet itself, the younger sediments lying below, and the deep basement below that. Previous studies suggested that a 10-km hole should be drilled in two phases. The first would be a narrow-diameter hole to approximately 2,400 m. The second stage would be a larger-diameter hole (approximately 46–61 cm) to the proposed total depth of 10 km.

Basic scientific research that has been proposed includes studying active silicic caldera systems, fossil silicic caldera systems, and in situ stress regime studies, as well as research into the petrology of the rocks associated with faulting. CSDC emphasized, however, that the program has no resource objective although private industry would certainly be interested in the results. In addition, the results, which might apply to other thin-crust overthrust areas of the world, already have been requested by scientists of other nations. Subsequent downhole studies also have been proposed.

Another proposal currently under review at NSF concerns the long-term managment of a national program of continental drilling, which could include the proposed Appalachian well but was not developed specifically with it in mind. The DOSECC (Deep Observational Sampling of Earth's Continental Crust) Group has submitted a 5-year proposal asking for roughly $30 million per year. According to Barry Raleigh, director of the Lamont-Doherty Geological Observatory and proponent for DOSECC, the group's primary objective is to manage the program for NSF with an emphasis on the scientific potential of such a long-term effort.

Speaking at a briefing of the NRC's Board on Earth Sciences in Washington, D. C., on October 11, Raleigh emphasized that the DOSECC proposal is related to the recommended Appalachian drill only insofar as this site would represent one well in a long-term national effort that the DOSECC group hopes to manage. As is inevitable, there has been some discussion within the geological community about whether large amounts of funding should be spent on one deep hole or spread out among many smaller wells. Thus far, DOE's approach to continental drilling has been the latter.—*DWR*

In Congress: Drilling Resolution

The following is the text of the resolution on continental scientific drilling passed by the Senate and the House of Representatives and signed into law by President Reagan on October 12.

"...That to express the sense of the Congress that the Continental Scientific Drilling Program is an important national scientific endeavor, benefiting the commerce of the Nation, which should be vigorously pursued by government and the private sector.

"The Continental Scientific Drilling Program is an important national scientific endeavor that is vital to the understanding of the geologic evolution of the Earth and the economic value of its resources;

"The most effective and efficient means of realizing the fullest potential in the Continental Scientific Drilling Program is through a cooperative effort by the Department of Energy, the National Science Foundation, and the United States Geological Survey;

"Many important commercial and scientific advances may result from the Continental Scientific Drilling Program; and

"Many foreign nations are engaged in a comparable deep drilling program, and cooperation and coordination would be beneficial to United States efforts.

"It is the sense of the Congress that—

(1) The Continental Scientific Drilling Program is an important national scientific endeavor by the United States which should be enthusiastically implemented through a joint cooperative effort among the United States Department of Energy, the National Science Foundation, and the United States Geological Survey;

(2) The private sector should be encouraged to support the Continental Scientific Drilling Program and the participating agencies should solicit appropriate private sector participation in such Program; and

(3) The United States Government should cooperate to the extent practicable with the international community in developing this important scientific and technical activity."

Alaskan Oceanography

Physical oceanographers, chemists, and biologists will soon begin studying the seas around northern Alaska as part of an international effort to learn how increased fishing, oil and gas drilling, and land-based farming will affect marine life. The $2.5 million National Science Foundation (NSF)– funded study, called ISHTAR (Inner Shelf Transfer and Recycling in the Bering and Chukchi Seas), will involve scientists from the United States, Belgium, and Denmark.

According to NSF, previous studies suggest that, despite a short growing season, the seas around the Bering Strait produce more plant life than most marine areas of the world. However, the source of mineral nutrients for this plant life and its destination in the food web or organic sediment is not well understood. The researchers will trace nutrients from the Yukon River and the deeper waters of the Bering Sea to the continental shelves of the Bering and Chukchi seas in an attempt to better understand what happens to land and marine organic matter when it enters this continental shelf ecosystem.

Preparation for the study will begin soon, with field work scheduled to begin in the spring of 1985. Taking part in the study will be scientists from the universities of Alaska, Washington, South Florida, and Texas and the Brookhaven National Laboratory. In addition, researchers from the University of Liege in Belgium and the University of Aarhus in Denmark will participate. The program, funded by NSF's division of polar programs, is headed by C. Peter McRoy of the University of Alaska.

Geophysical Events

This is a summary of *SEAN Bulletin*, 9(9), September 30, 1984, a publication of the Smithsonian Institution's Scientific Event Alert Network. The complete bulletin is available in the microfiche edition of *Eos* as a microfiche supplement or as a paper reprint. For the microfiche, order document E84–010 at $2.50 (U.S.) from AGU Fulfillment, 2000 Florida Avenue, N.W., Washington, DC 20009. For the paper reprint, order *SEAN Bulletin* (giving volume and issue numbers and issue date) through AGU Separates at the above address; the price is $3.50 for one copy of each issue number for those who do not have a deposit account, $2 for those who do; additional copies of each issue number are $1. Subscriptions to *SEAN Bulletin* are available from AGU Fulfillment at the above address; the price is $18 for 12 monthly issues mailed to a U.S. address, $28 if mailed elsewhere, and must be prepaid.

Volcanic Events

Erebus (Antarctica): vigorous explosions, clouds, and incandescent tephra.

Mayon (Philippines): Explosive activity reintensifies; 73,000 evacuated.

Api Siau (Indonesia): Seismicity and minor tephra emission since January; ash column and nuées ardentes in September.

Home Reef (Tonga): Pumice from March eruption found 1300 km to the WSW.

Ulawun (New Britain): Mild strombolian eruption.

Rabaul (New Britain): Seismicity, ground deformation rates decline.

Manam (Bismarck Sea): Ash-laden emissions, incandescence.

Unzen (Japan): Earthquake swarm.

Campi Flegrei (Italy): More $M > 3$ events with wider distribution, but seismic energy release unchanged and uplift slows.

Etna (Italy): lava flows, strombolian activity, and ash emission.

Kilauea (Hawaii): Phase 25; highest fountains of 1983–1984 eruption; tephra.

Mount St. Helens (Washington): New lobe in collapse zone on composite dome.

Villarica (Chile): Brief ash eruption; increased seismicity.

Atmospheric Effects: 2 years of lidar data from Germany summarized.

Mt. Erebus Volcano, *Ross Island, Antarctica (77.58°S, 167.17°E). The following is a report from Philip Kyle and Jürgen Kienle. All times are UT.*

"Brief reports from technical staff operating seismic instruments at Scott Base and infrasonic equipment at McMurdo Sound indi-

News *(cont. on p. 772)*

News *(cont. from p. 771)*

cate a significant change in eruptive activity at Mt. Erebus.

"Mt. Erebus, the southernmost active volcano in the world, has contained a convecting lava lake since 1972. The semicircular lake increased in size, reaching about 60 m in length by 1976. Since then, little change in size has occurred. Activity associated with the lava lake has consisted of quiet degassing with emission of about 230 metric tons of SO_2 and 21 metric tons of aerosol particles per day. Two to six small strombolian eruptions occurred per day, often ejecting bombs of anorthoclase phonolite onto the crater rim, about 220 m above the lava lake.

"The reports indicate that starting on September 13, a number of large explosions were recorded by the International Mt. Erebus Seismic Study (IMESS) network situated on the volcano, by infrasonic detectors in Windless Bight (about 20 km away), by the WWSSN seismograph at Scott Base (37 km distant), and by a tidal gravimeter at South Pole station (about 1400 km from Mt. Erebus). Previous strombolian activity has generally been too weak to record except on the IMESS seismic stations.

"From September 13 to 17 the volcano was very active, with 8–19 large explosions (recorded on WWSSN, IMESS, and infrasound instruments) per day, decreasing to 2–8 per day during September 20–25, then increasing again to 12–27 explosions per day during September 26–29. Numerous mushroom-shaped clouds were reported and were estimated to rise as much as 2 km above the summit of the 3794-m-high volcano. Observers at McMurdo, 37 km SW of the volcano, reported hearing explosions on September 16 at 0459, and September 20 at 1133 and 1135. Slight earth tremors were also felt there. On September 17 at 1010, a bright summit glow was observed from McMurdo Sound. Six minutes later, incandescent bombs were ejected to about 600 m above the summit; observers at Butter Point, 70 km from the volcano, reported seeing incandescent tephra from this explosion, which produced one of the larger infrasonic and seismic signals of the eruption sequence.

"Ash covered the NW side of the volcano down to 3400 m elevation. Fumaroles around the summit crater showed a substantial increase in activity. A 300–500-m-high very narrow plume was observed lower on the E flank (1800 m?). Observers suggested that it might have been a geyser."

Information Contacts: Philip R. Kyle, Coordinator, IMESS, Dept. of Geoscience, New Mexico Institute of Mining and Technology, Socorro, NM 87801; Jürgen Kienle and Charles Wilson, Geophysical Institute, University of Alaska, Fairbanks, AK 99701.

Mayon Volcano, *Luzon Island, Philippines (13.26°N, 123.68°E). All times are local (= UT + 8 hours). The following, primarily from Olimpio Peña, supplements the preliminary report in last month's bulletin.*

"Eruptive activity started September 9 at 1923. Initial activity was dominantly strombolian, with incandescent spattering at the summit and production of small lava flows. A mound of solidified lava inside the crater blocked the 1968 notch at the SW rim of the crater, so the small lava flows and initial pyroclastic flows (see below) moved predominantly NW.

"A fairly strong eruption September 10 at 2300 marked the start of vulcanian activity. Ash-laden steam clouds rose 5 km above the 2462-m summit, and a pyroclastic flow moved down to the NW, reaching 700 m elevation. Stronger explosions on September 11 reopened the notch at the SW rim, so more of the later lava and pyroclastic flows moved SW than NW. The eruption continued to intensify, peaking September 13. Cauliflower-shaped ash-laden steam clouds accompanied by rumbling sounds reached a maximum height of 15 km before drifting SW, W, and NW. Continuous volcanic tremors were recorded, punctuated by explosion earthquakes. Two lava flows emerged through the SW breach. One reached 500 m elevation adjacent to and W of the 1978 flow. The other, a little farther W, advanced to 1400 m elevation. The new lava is porphyritic augite-hypersthene andesite.

"Activity gradually declined September 14–21. A mild eruption on September 22 at 0502 was accompanied by a volcanic earthquake felt at intensity II on the Modified Rossi-Forel Scale at the Mayon Resthouse Observatory, at 700 m altitude on the NW flank. A relatively quiet period followed. A very strong explosion September 23 at 0433 ejected voluminous ash-laden steam clouds that reached 10 km in height. Incandescent tephra rose 2 km above the summit and spread in all directions, covering the summit area with red-hot tephra to about 1500 m elevation. A large notch was formed in the SE rim of the crater and a smaller one in the E rim. Subsequent pyroclastic flows were directed predominantly SE and E, although some moved in other directions along gulleys. Ash spread within about 50 km to the SW, W, and NW of the summit. Areas E and NE of the volcano received most of the fine airfall tephra generated by pyroclastic flows. The eruption continued to intensify until September 24. Voluminous ash emission, sometimes sustained for 5 minutes, occurred at intervals of 2–15 minutes and was accompanied by strong detonations and at times by electrical discharges. Maximum height of the eruption clouds was 15 km. On September 24, at 1614, a nuée ardente reached the nearest village. A large volume of pyroclastic flow material was deposited on the SE flank. The eruption started to decline September 25. By October 5, activity was limited to weak steaming and faint to moderate crater glow, accompanied by volcanic tremors and discrete earthquakes. Press sources reported reintensification of the eruption October 6. Ash-laden steam clouds rose as much as 1.7 km above the summit and lava flowed 1 km from the crater.

"Mudflows generated by rain destroyed three sections of the Legaspi-Santo Domingo highway roughly 8 km SE of the volcano. Larger mudflows on September 27 overran the same portion of highway. Two bridges were destroyed along the Mallilipot-Santo Domingo highway, roughly 8 km E of Mayon. As of September 30, press sources reported that 6,500 hectares of farmland had been covered by mudflows.

"Implementation of the Mayon preparedness plan was fairly smooth. On September 10, the area within 6 km of the summit was declared off-limits and all residents were recommended for evacuation. On September 12, the danger zone was extended to 8 km from the summit on the S and SW flanks. About 26,000 people were evacuated during the first phase of the eruption. On September 23, the danger zone was expanded again, to 10 km from the summit on the SE side and 8 km from the summit around the rest of the volcano. All residents of that area were recommended for evacuation, and the number of evacuees swelled to more than 73,000 at 50 centers. No casualties were attributed directly to the eruption or mudflows."

Information Contacts: Olimpio Peña, Philippine Institute of Volcanology, 5th Floor, Hizon Bldg., Quezon Blvd. Extension, Quezon City, Philippines; Deutche Presse-Agentur; Associated Press.

Api Siau Volcano, *Sangihe Islands, Indonesia (2.78°N, 125.48°E). All times are local (= UT + 8 hours). Adjat Sudradjat provided the following information, supplementing the report from press sources in last month's bulletin.*

An explosive eruption on September 5 was preceded by seismicity and minor tephra ejection.

Rumblings were heard on January 4, followed by an explosion that ejected ash. From February through April, rumbling preceded episodes of ash emission. On May 31 at 0724, an ash column rose to 1.5 km above the summit. During the night of June 7–8, glowing lava fragments were ejected from the main crater. On July 20, ash emission was accompanied by rumbling. The number of local seismic events increased through the first half of 1984 (see Table 1). Volcanic tremors were recorded August 24, although no surface activity was seen. Ash emission occurred September 3 at 0417, producing an eruption column that rose 600 m. Glowing lava fragments were occasionally ejected. Rumbling accompanied the activity.

TABLE 1. Number of Local Earthquakes per Month Recorded at Api Siau

Month, 1984	Tectonic Earthquakes	Volcanic Earthquakes
January	62	18
May	82	57
June	200	139
July	436	85

Data courtesy of Adjat Sudradjat.

On September 5 at 0905, an ash column rose 4 km from the main crater. Nuées ardentes flowed 2 km to the south and 1 km to the west, with estimated volumes of 1.5 and 0.5×10^6 m^3. One week later, ash emission was continuing and weak rumbling was heard. Ten volcanic and five tectonic earthquakes were recorded daily through September 16. About 4500 people were temporarily evacuated from the south and west sides of the danger zone but were allowed to work in their fields during the day. No casualties were reported.

Information Contacts: Adjat Sudradjat, Director, Volcanological Survey of Indonesia, Diponegoro 57, Bandung, Indonesia.

Meteoritic Events

Fireballs: SE, SW Australia; New Zealand; N Pacific Ocean (2500 km SW of Hawaii); S Florida, NW Georgia, central Kansas-Nebraska, W Nebraska, central Oklahoma, W Oregon–E Washington, E Texas, E Washington (2).

Earthquakes

Date	Time, UT	Magnitude	Latitude	Longitude	Depth of Focus	Region
Sept. 10	0314	6.7 M_s	40.49°N	126.78°W	10 km	off N California
Sept. 13	2349	6.2 M_s	35.76°N	137.48°E	5 km	Central Honshu, Japan
Sept. 17	0909	6.5 M_s	32.07°S	178.31°W	shallow	S of Kermadec Islands
Sept. 18	1326	5.4 m_b	40.47°N	42.09°E	10 km	E Turkey
Sept. 18	1703	6.8 M_s	34.00°N	141.44°E	shallow	off E coast of Honshu
Sept. 28	0004	6.9 M_s	25.76°S	176.18°W	shallow	S of Fiji Islands

Information Contact: National Earthquake Information Service, U.S. Geological Survey, Stop 967, Denver Federal Center, Box 25046, Denver, CO 80225.

Recent Ph.D.'s

Eos periodically lists information on recently accepted doctoral dissertations in the disciplines of geophysics. Faculty members are invited to submit the following information, on institution letterhead, above the signature of the faculty advisor or department chairman:

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If possible include the current address and telephone number of the degree recipient (this information will not be published).

Dissertations with order numbers, and many of the others listed, are available from University Microfilms International, Dissertation Copies, P.O. Box 1764, Ann Arbor, MI 48106.

Active Remote Sensing of Ocean Parameters, An Engineering Study, J. D. Byrne, Optics, Dep. of Physics, Univ. of Miami, 1984.

Aerosol Sampling Bias From Differential Electrostatic Charge and Particle Size, M. A. Jayjock, Atmos. Sci., Dep. of Phys., Drexel Univ., 1984.

Analysis of Laramide and Younger Deformation of a Segment of the Big Bend Region, Texas, A. R. Moustafa, Dep. of Geol., Univ. of Tex. at Austin, 1983.

Application of Stable Isotopes of Oxygen, Hydrogen, and Carbon to Hydrogeochemical Studies, With Special Reference to Canada Del Oro Valley and the Tucson Basin, S.-L. Cheng, Dep. of Geochem., Univ. of Ariz., 1984.

Applications of Teleseismic Body Waves to Shallow Earth Structure, J. P. Stefani, Dep. of Geophys., Stanford Univ., 1984.

Arctic Haze: Meteorological Aspects of Long-Range Transport, W. E. Raatz, Atmos. Sci., Dep. of Phys., Univ. of Alas., 1983.

Auroral Zone Thermospheric Dynamics Using Fabry-Perot Interferometer Measurements of the OI 15867Å Emission, R. J. Sica, Dep. of Space Phys. and Atmos. Sci., Univ. of Alas. (M. H. Rees), August 1984.

Born Inversion Applied to Reflection Seismology, C.-Y. Lui, Dep. of Geophys., Univ. of Tulsa, 1984.

Broken-Formations of the Pulaski Thrust Sheet Near Pulaski, Virginia, A. P. Schultz, Dep. of Geol., Va. Polytech. Inst. and State Univ., 1983.

Characterization of Aquatic Use Attainment in Oklahoma, C. L. Marshall, Dep. of Environ. Sci., Univ. of Okla., 1984.

Chemical Evidence for Advection of Hydrothermal Solutions in Ridge Flank Sediments, C. R. P. Maris, Dep. of Geochem., Univ. of R. I., 1983.

Chlorine in Groundwater: Stable Isotope Distribution, R. S. Kaufmann, Dep. of Geochem., Univ. of Ariz., 1984.

A Comparison of Seismic Properties of Young and Mature Oceanic Crust, M. Bee, Dep. of Geophys., Oreg. State Univ., 1984.

A Comparison of Two- and Three-Dimensional Transport Within A Stratospheric Circulation Model, H.-R. Schneider, Atmos. Sci., Dep. of Phys., Univ. of Miami, 1984.

A Consideration of the Mechanism of Pulmonary Adenogenesis in Urethane-Treated Swiss Cox Mice, S. P. Sichak, Dep. Environ. Sci., Univ. of Cincinnati, 1984.

Coupling Between Fluid Flow and Deformation in Porous Crustal Rocks, J. S. Walder, Dep. of Geophys., Stanford Univ., 1984.

Crustal Shear Velocity Modeling in Nevada: A Study of Broadband Multi-Mode Surface Waves, K.-Y. Chun, Dep. of Geophys., Univ of Calif., Berkeley, 1983.

Deformation of the Subsurface Silurian and Devonian Rocks of the Southern Tier of New York State, K. J. Beinkafner, Dep. of Geol., Syracuse Univ., 1983.

Deposition and Diagenesis of the Brushy Basin and Upper Westwater Canyon Members of the Morrison Formation in Northwest New Mexico and Its Relationship to Uranium Mineralization, T. E. Bell, Dep. of Geol., Univ. of Calif., Berkeley, 1983.

Depositional History and Sedimentology of Upper Cretaceous Mancos Shale and Lower Mesaverde Group, Northwestern Colorado: Migrating Shelf-Bar and Wave-Dominated Shoreline Deposits, J. M. Boyles, Dep. of Geol., Univ. of Tex. at Austin, 1983.

Direct Examination of Biologically Active Copper in Seawater, N. R. Giunio-Zorkin, Dep. of Oceanogr., Univ. of B. C., Vancouver, August 1983.

Dissolved Organic Carbon Facilitated Transport of Neutral Organic Compounds in Subsurface Systems, C. C. West, Dep. of Environ. Sci., Rice Univ., 1984.

The Effects of Spatial Averaging on Airfoil Probe Measurements of Oceanic Velocity Microstructure, R. M. Ninnis, Dep. of Oceanogr., Univ. of B. C., Vancouver, July 1984.

Electric Conductivities, Currents and Energy Dissipation in the Polar Ionosphere, B.-H. Ahn, Atmos. Sci., Dep. of Phys., Univ. of Alas., 1983.

Eolian Quartz Granulometry as a Paleowind Indicator in the Northeast Equatorial Atlantic, North Pacific and Southeast Equatorial Pacific, J. P. Dauphin, Dep. of Geol., Univ. of R. I., 1983.

Estimation of Aquifer Parameters Under Transient and Steady-State Conditions, J. Carrera-Ramirez, Dep. of Hydrol. and Water Resour., Univ. of Ariz., August 1984.

Estuarine Microplankton Ecology: An Experimental Approach, A. Spies, Dep. of Oceanogr., Univ. of B. C., Vancouver, November 1983.

Forms of Large Folds in the Central Appalachians, Pennsylvania, S. Aytuna, Dep. of Geol., Univ. of Cincinnati, 1984.

A Fully Internal Hybrid Technique for Calculating Electromagnetic Scattering From Three-Dimensional Bodies in the Earth, W. R. Petrick, Dep. of Geophys., Univ. of Utah, 1984.

Generalized Linear Inversion of 2.5-Dimensional Gravity and Magnetic Anomalies, S.-F. Lai, Dep. of Geophys., Univ. of Texas at Dallas, 1984.

Generalized Velocity Filters, Shot-Size Calibration in the Frequency Domain, and Seismotectonic Study in the Northeastern United States, J.-P. Yang, Dep. of Geophys., Columbia Univ., 1984.

Geochemical Behavior and Distribution of Copper and Iron in Marine Waters, J. L. Symes, III, Dep. of Geochem., Univ. of R. I., 1983.

Geological Development of the Southern Long Range Mountains, Southwest Newfoundland: A Regional Synthesis, L. B. Chorlton, Dep. of Geol., Mem. Univ. of Newfoundland, 1984.

The Geographic and Statistical Analysis of Air Quality Data in the United States, L. D. Johnson, Dep. of Biostatist., Univ. of Calif., Berkeley, 1983.

Geology and Geochemistry of Early Tertiary Submarine Volcanic Rocks of the Aleutian Islands, and Their Bearing on the Development of the Aleutian Island Arc, J. Rubenstone, Dep. of Geol. Sci., Cornell Univ., May 1984.

Geomorphology and Hydrogeology of the Edwards Plateau Karst, Central Texas, E. H. Kastning, Jr., Dep. of Geol., Univ. of Tex. at Austin, 1983.

The Hall Molybdenum Deposit, Nye County, Nevada: Geology, Alteration, Mineralization, and Geochemical Dispersion, S. A. Shaver, Dep. of Geol., Stanford Univ., 1984.

Increases and Fluctuations in Thermal Activity at Mount Wrangell, Alaska, R. J. Motyka, Dep. of Geophys., Univ. of Alas., 1983.

Influence of Naturally Occurring Carbon Substrates on the Biodegradation of Mono-Substituted Phenols by Aquatic Bacteria, R. J. Shimp, Dep. of Environ. Sci., Univ. of N. C. at Chapel Hill, 1984.

Isotopic and Chemical Studies of the Deccan and Rajmahal Traps, India: Mantle Sources and Petrogenesis, J. J. Mahoney, Scrips Inst. of Oceanogr., Univ. of Calif., San Diego (J. D. Macdougall), June 1984.

Late Quaternary Glacial Cycles in the Bahamian Deep Basins and in the Adjacent Atlantic Ocean, A. W. Droxler, Dep. of Geol., Univ. of Miami, 1984.

Local Climatological Investigation of Wind Fields in the Lower Monongahela Valley of Allegheny County, Pennsylvania, B. L. Biro, Dep. of Phys. and Atmos. Sci., Univ. of Pittsburgh, 1983.

Localized Stress Drops of Great Thrust Earthquakes: Importance to Strong Ground Motion, J. J. Mori, Dep. of Geol. Sci., Columbia Univ. (P. Richards), July 1984.

Magnetostratigraphy of Neogene and Quaternary Siwalik Group Sediments of the Trans-Indus Salt Range, Northwestern Pakistan, M. J. Khan, Dep. of Geophys., Columbia Univ., 1983.

Measured and Calculated Solar Radiation in an Aerosol Atmosphere, L. J. B. McArthur, Atmos. Sci., Dep. of Phys., McMaster Univ., 1984.

Microbial Involvement in Trace Organic Removal From Groundwater Recharge During Rapid Infiltration, S. R. Hutchins, Dep. of Environ. Sci., Rice Univ., 1984.

The Nature of the Precambrian Subcontinental Mantle: Isotopic Study of the Keweenawan Volcanism of the North Shore of Lake Superior, L. Dosso, Dep. of Geochem., Univ. of Minn., 1984.

Neogene Paleoceanography of the Equatorial and North Pacific Ocean, K. K. Romine, Dep. of Paleoecol., Univ. of R. I., 1983.

Nitrate and Non-Sea-Salt Sulfate Aerosols Over Major Regions of the World Ocean: Concentrations, Sources, and Fluxes, D. L. Savoie, Dep. of Chem., Univ. of Miami, 1984.

Nitrogen Cycling in Potomac River Transition–Zone Shallow–Water Sediments, N. S. Simon, Dep. of Geochem., Amer. Univ., 1984.

On the Occurrence and Origins of Hopanoids in the Chesapeake Bay, G. Wattayakorn, Dep. of Geochem., Coll. of William and Mary, 1983.

Operation of a Metropolitan Water Supply System During Drought, D. Randall, Sch. of Civil Eng., Purdue Univ. (M. H. Houck), December 1984 (requirements completed September 1984).

Paleoenvironmental Interpretation of the Upper Cretaceous Pt. Lookout Sandstone: Implications for Shoreline Progradation and Basin Tectonic History, San Juan Basin, New Mexico, R. Wright, Dep. of Geol., Rice Univ., 1984.

Paleogeography and Tectonics of the Redding Section, Eastern Klamath Belt, Northern California, S. W. Fagin, Dep. of Geol., Univ. of Tex. at Austin, 1983.

A Paleomagnetic Study of the Prince William Terrane and Nixon Fork Terrane, Alaska, P. W. Plumley, Dep. of Geol., Univ. of Calif., Santa Cruz, 1984.

Paleomagnetism and Tectonic Studies of the Scaglia Rossa Pelagic Limestones (Upper Cretaceous-Eocene) from the Umbria-Marches Apennines, Italy, L. S. Chan, Dep. of Geol. and Geophys., Univ. of Calif, Berkeley (W. Alvarez), December 1984.

Paleomagnetism of the Wrangellia and Alexander Terranes and the Tectonic History of Southern Alaska, B. C. Panuska, Dep. of Geol. and Geophys., Univ. of Alas. (D. B. Stone), September 1984.

Parametric Acoustic Conversion in Ocean Sediments, S. W. Yoon, Dep. of Phys. and Acoust., Univ. of Tex. at Austin, 1983.

Particle Fluxes in the Eastern Tropical Pacific Ocean—Sources and Process, K. M. Fischer, Dep. of Geochem., Oreg. State Univ., 1983.

The Petrology and Geochemistry of High Cascade Volcanics in Southern Washington: Mount St. Helens Volcano and the Indian Heaven Basalt Field, D. R. Smith, Dep. of Geol., Rice Univ. (W. P. Leeman), May 1984.

Petrology of Basement Rocks of the California Continental Borderland and the Los Angeles Basin, S. S. Sorensen, Dep. of Geol., UCLA, 1984.

Petrology of Deep Crustal Xenoliths From the Eastern Snake River Plain, Idaho, D. J. Matty, Dep. of Geol., Rice Univ., 1984.

Physiological Effects of Simultaneous Exposure to Heat and Vibration, W. A. Spaul, Dep. of Environ. Sci., Univ. of Calif., Berkeley, 1983.

Quasi-Stationary Atmospheric Responses to Large-Scale Forcing, I.-S. Kang, Atmos. Sci., Dep. of Phys., Oreg. State Univ., 1984.

Relationships Between Grass Canopy Characteristics and Landsat Thematic Mapper Bands, W. J. Ripple, Dep. of Environ. Sci., Oreg. State Univ., 1984.

Resin Acid Compounds in a Kraft Pulp and Paper Mill Effluent and Their Distribution in Bottom Sediments Near the Outfall, M. Unkulvasapaul, Dep. of Environ. Sci., Coll. of William and Mary, 1984.

Retrieval of Thermal and Microphysical Variables in Observed Convective Storms, C. L. Ziegler, Dep. of Phys. and Atmos. Sci., Univ. of Okla, 1984.

Sedimentology of the Moosebar and Gates Formations, D. A. Leckie, Dep. of Geol., McMaster Univ., 1984.

Seismic Structure Across the Active Subduction Zone of Western Canada, G. D. Spence, Dep. of Geophys. and Astron., Univ. of B. C., Vancouver (R. M. Clowes, R. M. Ellis), July 1984.

The Shear Wave Velocity Structure of the Lithosphere in Central and Northern California, A. R. Levander, Dep. of Geophys., Stanford Univ., 1984.

Shelf Circulation Studies on the Northeastern United States Continental Shelf, M. A. Noble, Dep. of Phys. Oceanogr., Univ. of R. I., 1984.

Silicic Volcanism at Twin Peaks, West-Central Utah: Geology and Petrology, Chemical and Physical Evolution, Oxygen and Hydrogen Isotope Studies, H. R. Crecraft, Dep. of Geol., Univ. of Utah, 1984.

Some Boundary Integral Equation Methods and Their Application to Seismic Exploration, G. T. Schuster, Dep. of Geophys., Columbia Univ., 1984.

Source Parameters and Faulting Process of the August 1959 Hebgen Lake, Montana Earthquake Sequence, D. I. Doser, Dep. of Geophys., Univ. of Utah, 1984.

Spatial and Temporal Variations in Bulk, Wet, and Dry Atmospheric Deposition of Acidity and Minerals Across Florida, C. D. Hendry, Jr., Dep. of Chem., Univ. of Fla., 1983.

Strain Release Along Oceanic Transform Faults, L. M. Stewart, Dep. of Geophys., Yale Univ., 1983.

A Study of Greenhouse Effects Using Zero, One and Two-Dimensional Climate Models, H. N. Dalfes, Atmos. Sci., Dep. of Phys., Rice Univ., 1984.

A Study of Highly Energetic Near-Bottom Ocean Flow at the Base of the Scotian Rise, E. A. Kelley, Jr., Dep. of Phys. Oceanogr., Fla. State Univ., 1984.

Submarine Sand Ridges: Geology and Development, New Jersey, U.S.A., A. G. de Figueiredo, Jr., Dep. of Phys. Oceanogr., Univ. of Miami, 1984.

Sunlight Through the Clouds: Economic and Environmental Effects of Centralized and Dispersed Photovoltaic Power Systems in Electric-Utility Applications, I. M. Mintzer, Dep. of Environ. Sci., Univ. of Calif., Berkeley, 1983.

Tadjik Depression, U.S.S.R.: Geology, Seismicity and Tectonics, W. Leith, Dep. of Geol. Sci., Columbia Univ. (C. Scholz, D. Simpson), July 1984.

Tectonic Evolution of a Segment of the West Spitsbergen Foldbelt in Northern Wedel Jarlsberg Land, E. C. Hauser, Dep. of Geol. and Geophys., Univ. of Wisc.-Madison (C. Craddock), December 1982.

Tectonics of an Allochthonous Terrane, the Yakutat Block, Northern Gulf of Alaska, T. R. Bruns, Earth Sci. Board, Univ. of Calif., Santa Cruz (E. A. Silver), June 1984.

Topics on Equatorial Responses to Spatially and Temporally Varying Zonal Wind Stress, T. Y. Tang, Dep. of Mar., Earth and Atmos. Sci., N. C. State Univ. (R. H. Weisberg), May 1984.

Trace Elements and Radionuclides in the Connecticut River and Amazon River Estuary, E. P. Dion, Dep. of Geochem., Yale Univ., 1983.

Two-Dimensional Velocity Anomaly Reconstruction by Seismic Tomography (SIRT), N. J. Wattrus, Dep. of Geophys., Univ. of Minn., 1984.

Upper Mantle Structure From Long-Period SH, S. F. Ingate, Res. Sch. of Earth Sci., Austr. Natl. Univ., Canberra, May 1984.

Uranium(VI) Transport Modeling: Geochemical Data and Submodels, V. S. Tripathi, Dep. of Geochem., Stanford Univ., 1984.

The Use of Photoionization and Other Detectors for Gas Chromatographic Determination of Gaseous Air Pollutants, W. Nutmagul, Dep. of Chem., Wash. State Univ., 1984.

Using the Global Positioning System (GPS) Phase Observable for Relative Geodesy: Modeling, Processing, and Results, B. W. Remondi, Dep. of Aerosp., Univ. of Tex. at Austin (B. D. Tapley), May 1984.

Velocity Microstructure Measurements in the Western and Central Equatorial Pacific, J. N. Moum, Dep. of Oceanogr., Univ. of B. C., Vancouver, May 1984.

Books

Proceedings in Atmospheric Electricity

Lothar H. Ruhnke and John Latham (Eds.), A. Deepak, Hampton, Va. 1983.

Reviewed by Leslie Hale

It is widely accepted that atmospheric electricity is a fundamental discipline of great importance; it is equally true that progress in some parts of this field has been erratic. It has frequently attracted bright young people who have left for "hotter" areas. Specifically, it supplied much of the talent in cosmic ray physics, and, more recently, the field was decimated by the literally greener pastures in space science. Still, there remains a hard core of serious workers who are convinced of the ultimate scientific importance of their field including relevance to other areas (meteorology, space science, and possible relationships between them).

The very nonuniform series of books resulting from conferences held every 4 years or more starting in 1954 provides a history of the field in the postwar years and, along with the great summary of work prior to 1972 in the book *Atmospheric Electricity* by Israël, makes up the most essential collection of reference material. With admittedly gross oversimplification, I have tried to characterize briefly the books leading up to the latest volume.

The first two meetings were held on the New Hampshire seacoast, in 1954 and 1958, under the auspices of what is now the Air Force Geophysical Laboratory. In the first relatively slender volume a successful attempt was made by an older generation (e.g., Israël, Swann, Wormell) to define the problems in ionization, thunderstorm electrification, and the global electrical circuit. A young Bernard Vonnegut apposed his convective electrification scheme to the more established precipitation theories. The second volume, much thicker, shows a vigorous experimental program in progress in both the atmosphere and the laboratory, with the appearances of many of the basic quantitative data relating to atmospheric ions and fields, including those due to lightning. Marx Brook and others described electrification involving ice particles. An ominous note was sounded by the announcement on the very last page that the Air Force was terminating major support in the area.

From the 1963 meeting in Montreux a smaller volume reflects the decrease in experimental work resulting from reduced U.S. funding, but the increased contributions from other countries under international auspices and a number of theorectical papers consolidating earlier gains made this an essential reference work. B. J. Mason leads off the section on electrification with a paper on ice precipitation theory which is rebutted by C. B. Moore and the section contains a spirited—to say the least—discussion between Vonnegut and Ross Gunn on convective versus precipitation mechanisms. The last section is a promising introduction to "space electricity," keynoted by John F. Clark, who had recently transferred from atmospheric electricity to space science, as so many did.

A finely produced two volume set, *Planetary Electrodynamics*, resulted from the 1968 Tokyo meeting. Volume I, mainly on "classical" atmospheric electricity, contains a number of fine survey papers but, possibly because of fear of losing respectability, was so tightly edited as to stifle controversy. Volume 2 starts with material on global (Schumann) resonances and contains some excellent but now dated papers on space electric fields and Narcisi's early work on cluster ions.

The very large (and very expensive) "yellow book" resulting from the 1974 meeting in Garmisch-Partenkirchen turned out to be a delightful surprise, comparable only to Israël in its current value as a general reference work in this field. It contained a wealth of new material and was edited deftly enough that some controversial ideas are given an airing without denigrating the overall quality of the book. The published discussion was a very valuable part of the book, and space electricity was allotted a proper but not dominant role.

For reasons not entirely clear, but I suspect related to funding, the latest volume, resulting from a meeting in Manchester in 1980, is not up to the standard set by the rest of the series. It is a collection of relatively uniform length camera ready "extended abstracts" without appended discussion, covering a selected group of the papers presented. This is not to imply that the quality of the contributions is low, however.

The part of the book on ions and conductivity provides an excellent summary of this area up to 1980 and contains much of the important stratospheric work in this area, including the Heidelberg mass spectrometry work and material on clustering and aerosol formation by a number of groups. A longer review paper by Frank Arnold and Eldon Ferguson provides a backbone that the other sections are lacking.

A good but too short introductory review paper on electrification processes by Tony Illingworth raises the intriguing possibility that the precipitation-convection controversy may be resolved in the happiest possible way, with both sides being right.

Many of the contributions come across as "progress reports," of dubious value at this late date. I would have preferred a format involving longer review papers and shorter abstracts of most other papers including some controversial papers which were edited out (including two of mine) and at least some discussion.

The late date of publication is a reminder that progress is being made in atmospheric electricity. There is only a brief reference by Phil Krider to the idea that a solenoidal Maxwellian current (usually mostly displacement current below thunderclouds) is the relatively invariant electrical output of thunderclouds between lightning flashes and is more directly related to the electrophysics of the thundercloud than electric field or conduction current. This idea has undergone considerable development since the Manchester meeting, and is certainly a great advance from the ideas of 1954 where ways were sought to eliminate from measurements the "troublesome influence current," which now turns out to contain most of the action. I always thought Maxwell got too much credit for getting his name on the whole set of equations for contributing one additional term, but, to paraphrase what someone said about something, "Oh, what a term!"

In summary, the latest volume in the series fulfills the purpose of keeping the flame alive in a time of financial stringency and will certainly be bought by libraries and others to keep a complete set. First time buyers would be advised first to obtain Israël and the yellow book, to which the latest volume serves as an update. Perhaps we can look forward to a book from the recent Albany meeting more in keeping with the traditions of this important series.

Leslie Hale is A. Robert Noll Professor of Electrical Engineering at The Pennsylvania State University, University Park.

Advances in Infiltration

Donald C. Slack (Ed.), American Society of Agricultural Engineers, St. Joseph, Mich., 385 pp., 1983, $27.50

Reviewed by Robert Mansell

During December 12–13 of 1983, in Chicago, the American Society of Agricultural Engineers (ASAE) convened the National Con-

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Books (cont. from p. 773)

ference on Advances in Infiltration. The stated purpose of the conference was to report and evaluate recent developments in the movement of water into soil. Ninety papers were presented at the conference, but only 36 manuscripts are included in this volume, which represents the proceedings for the conference. Six manuscripts each are presented under the designated topics of physics of infiltration, parameters in infiltration equations, special problems and phenomena, measurement of infiltration, applications in agriculture, and applications in watershed hydrology. Brief abstracts are included for 23 papers presented in poster sessions at the conference.

A 10-page summary of the proceedings is conveniently provided for those readers who wish to obtain a quick overview and perspective for published contributions. The purpose of the summary is ". . .to select the key points or findings from the conference papers and to integrate this information under topical headings." These headings "resemble but do not match" proceeding topics. Infiltration models were divided into basic equations of porous media flow (nine papers), physically based models (five papers), and empirical equations (four papers). The author of the summary concludes that a major strength of the proceedings is the extension of infiltration theory by a number of authors beyond overly simplified assumptions commonly associated with one-dimensional flow into homogeneous soil. More realistic cases are presented which account for multidimensional soil-water flow, preferential flow through macropores, air effects (multiphase flow), effects of surface sealing, soil-water hysteresis and redistribution during the postinfiltration period, effects of slowly permeable subsurface soil layers, and ice effects in frozen soils. Development of simplified models for conditions more complex than one-dimensional infiltration into homogeneous soil is a suggested need for future research. Another stated strength is the emphasis upon evaluation, spatial variability, and temporal variability of infiltration parameters. Particular attention was given to hydraulic properties of soil as well as to integral and empirical parameters. Improvement in parameter evaluation is also suggested as a major need for further research. A third stated strength is improvement in the measurement of infiltration in the field by use of the direct techniques of ring, furrow, and sprinkler infiltrometers and indirect techniques involving time domain reflectometry and passive microwaves. Additional improvement in accuracy and efficiency of infiltration measurement is listed as a research need.

The reviewer found two of the papers on multidimensional soil water flow especially interesting. Infiltration from irrigation furrows, trickle irrigation systems, subsurface disposal of effluent from septic tanks, and surface application of treated domestic wastewater by overhead sprinklers are but a few examples of situations in which only a fraction of a given soil receives water application, causing flow to occur in two and three dimensions. Using quasi-linearized forms for the multidimensional form of the Richards equation, two different authors presented analytical models for multidimensional infiltration. One author presented analytical models for two- and three-dimensional steady infiltration where water is applied to geometric patterns of "fractional wetting" of the soil surface. At "shallow" soil depths the need for these models, which describe the multidimensional aspects of water flow, was clearly shown. However, below some characteristic depth, water from all surface areas of water application coalesces. At that point, simpler models for one-dimensional infiltration were shown to be adequate. The second author described a general analytical model for transient two-dimensional infiltration in which water is applied at specified intensity to the soil surface in strips separated by zones of evaporation. The model can be used for nonuniform and nonperiodic strip sources. The model is time dependent and capable of providing valuable insight into the transient nature of two-dimensional flow from periodic strip sources with the simpler cases of uniform infiltration and evaporation. Both of these papers provide important new concepts and mathematical tools for improving the understanding of infiltration physics for multidimensional flow.

This book is recommended as an excellent resource book for recent developments concerning water entry into soil.

Robert Mansell is with the Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611.

The Morphostructure of the Atlantic Ocean Floor: Its Development in the Meso-Cenozoic

V. M. Litvin (transl. from the Russian by V. M. Divid, N. N. Protsenko, and Yu. U. Rodzhabov), D. Reidel, Hingham, Mass., x + 172 pp., 1984.

Reviewed by Dennis E. Hayes

The Morphostructure of the Atlantic Ocean Floor is a useful review of the principal morphologic, tectonic, sedimentary, and geophysical features of the Atlantic Ocean. The treatment of these topics is primarily a descriptive one based mostly upon data collected by Soviet scientists. The book is a recent translation of a 1980 edition published in Russian and as such suffers in two important ways: (1) The material and views presented take virtually no cognizance of research done since the mid-1970's and (2) the actual translation is often awkward (for example, platform tectonics instead of plate tectonics; ocean bottom spreading instead of seafloor spreading; bathography instead of bathyorographical or, better still, morphology).

V. M. Litvin is a scientist of international stature and his book provides a worthwhile if slightly dated descriptive summary of the morphology and evolution of the Atlantic Ocean floor. Although there are no new scientific insights presented in the book, the large collection of mostly Soviet references will be of interest to Atlantic Ocean researchers.

Dennis E. Hayes is with the Lamont-Doherty Geological Observatory, Palisades, N.Y. 10964.

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POSITIONS AVAILABLE

Postdoctoral Position/Oregon State University. Research Associate (postdoctoral), at Oregon State University's Cooperative Institute for Marine Resources Studies. Expertise in physiological and chemical ecology with interest in interactions of hydrothermal vent fauna with the unique biogeochemical properties of their environment. Familiarity with state-of-the-art analytical techniques (GC, GC/MS, HPLC) highly desirable. One (1) year, renewable for a second year subject to approval. Send C.V., names and addresses of three (3) references by 30 November 1984 to Director, CIMRS, Hatfield Marine Science Center, Newport, Oregon 97365.

OREGON STATE UNIVERSITY, AN AFFIRMATIVE ACTION/EQUAL OPPORTUNITY EMPLOYER, COMPLIES WITH SECTION 503 OF THE REHABILITATION ACT OF 1973.

Harvard University/Faculty Position in Petrology. The Department of Geological Sciences, Harvard University, invites applications for a faculty position in petrology. We are interested in persons concerned with the mineralogy and the major and/or trace element chemistry of metamorphic and igneous rocks in relation to their geologic and tectonic setting. Experience with modern methods for the study of natural rocks, both in laboratory and in the field, is essential. The successful applicant must have the Ph.D. degree by the time of appointment and demonstrated capabilities to conduct original research and to teach both undergraduate and graduate students. The appointment will be made at the Assistant or Associate Professor level depending on qualifications and experience. The 1984/85 salary ranges are $26,600–$28,200 for Assistant Professor and $30,600–$35,600 for Associate Professor. Appointments are made for an initial term of up to five years. Interested applicants should send vita, bibliography, and names of three references to:

Professor Adam M. Dziewonski
Harvard University
Hoffman Laboratory
20 Oxford Street
Cambridge, MA 02138.

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Department of Geosciences/University of Houston. The Department of Geosciences has permission to hire at least one geophysicist to complement the 16 members of our faculty (5 in Geophysics). This is a tenure track position with a starting date of August, 1985. We are particularly interested in talking with individuals with strong backgrounds in theoretical and experimental seismology. Salary and rank will be determined on an individual basis. Applicants should submit: (1) a curriculum vita; (2) a brief statement outlining research interests; (3) a brief statement outlining teaching interests; (4) three letters of recommendation; (5) a copy of graduate transcripts.

John C. Butler
Geosciences
University of Houston, University Park
Houston, Texas 77004.

Several of my colleagues and I will be at the GSA meetings in Reno and would like to talk with potential applicants.

The University of Houston is an equal opportunity/affirmative action employer.

Faculty Position in Structural Geology/Tectonics. The Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, has a tenure track opening at the Assistant or Associate Professor level in the area of structural geology/tectonics. The position will be filled for the beginning of the Fall 1985 term. The department currently has 31 full-time faculty, including 12 geologists and geophysicists.

The successful applicant will be expected to have completed the PhD degree. Courses to be taught include undergraduate structural geology as well as courses in structural analysis, tectonics, or other areas of research activity. He or she additionally will be expected to develop a vigorous program of sponsored research and to direct graduate student research projects at the MS and PhD level.

Please send complete resume and the names of at least three references to V.V. Cavaroc, Search Committee Chairman, Department of MEAS, North Carolina State University, Raleigh, NC 27695-8208; phone (919) 737-2212. Applications will be considered as received, with a closing date of January 15, 1985.

North Carolina State University is an equal opportunity/affirmative action employer.

Civil Engineering. Tenure track position is available in the Department of Civil Engineering for an assistant or associate professor with interest in Hydraulics. Duties include teaching undergraduate and graduate courses, research and advising. Requires B.S. and Ph.D. in Civil Engineering or closely related area. Applicants with prior teaching experience and research experience in hydraulic modeling, sediment transport, river mechanics and computer applications to hydraulics given preference. Must be interested in pursuing contract and grant research support. Demonstrated ability in written and oral communication preferred. Application deadline is January 15, 1985. However position may be reopened with limited advertisement if suitable candidate is not identified. Position available as early as Summer 1985.

Send resume, including biographical data, grade transcripts, teaching experience, research interests, publications and three references to Constantine Papadakis, Head, Civil Engineering Department, Colorado State University, Fort Collins, Colorado 80523.

CSU is an EEO/AA employer. E.O. Office: 314 Student Services Building.

Physical Oceanographers. The Physical Oceanography Branch of the U.S. Naval Oceanographic Office seeks full-time Oceanographers for the study of the effects of oceanic current and thermal/density structure on undersea systems using data collected from various platforms for a variety of projects. The projects involve the collection, analysis and reporting of physical oceanographic data directly applicable to relevant Navy environmental requirements. Up to 50% field duty may be required.

Multiple vacancies at the GS-7, 9 and 11 levels are available depending upon qualifications and experience and will remain open until filled. Salary range: $17,221 to $33,139.

Please contact (for required forms): Debra Staples, #N00-72(84), Commercial 601-688-5720, Autovon 485-5720, or FTS 494-5720. U.S. Naval Oceanographic Office, Management & Personnel Division, Personnel Operations Branch, Code 4320, Bay St. Louis, NSTL, Mississippi 39522.

University of Utah: Structural Geology/Tectonics/Tectonophysics. The Department of Geology and Geophysics at the University of Utah seeks applications for a tenure track position in structural geology, tectonics or tectonophysics. It is anticipated that this position will be filled at the assistant professor level, but applications by more senior persons will be considered. The position requires a Ph.D. with emphasis in structural geology, regional tectonics or tectonophysics. The new faculty member will have the opportunity to teach in the area of his or her specialty and may also be assigned introductory level courses. The successful candidate will be expected to establish a vigorous research program involving graduate students. The person who fills this position will join an active program in structural geology and tectonics that includes both field projects and integrated geology/geophysics and mechanics/fluid chemistry studies of structures in the western Cordillera. There is an excellent opportunity to collaborate with other faculty in structural geology, sedimentology, geophysics, geochemistry and petrology. A vita, copies of publications, names of three persons that may provide references, and a letter outlining the candidate's research and teaching interests should be sent to Dr. William P. Nash, Chairman, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112-1183. Deadline for receipt of applications is December 31, 1984 with the appointment starting in September 1985.

The University of Utah is an equal opportunity/affirmative action employer.

Montana Bureau of Mines & Geology/Montana Tech. Applications are invited for a non-tenure track academic research appointment in hydrogeology to be filled at the research instructor or research assistant professor level.

This position will have broad research responsibilities in one or more of the following areas: regional and site-specific hydrogeological studies, hydrogeologic and hydrochemical aspects of surface coal mining and reclamation, and assessment of aquifer characteristics by aquifer testing and hydrochemical evaluations. The position entails considerable field work and will be located in Billings, Montana.

Candidates must have a Master's degree (Ph.D. preferred) in Hydrogeology or a related science and at least three years of hydrogeological experience, with emphasis on analysis and quantitative aspects of hydrogeology.

The closing date for applications is November 12, 1984. Salary will be $26,000—$33,000/year depending upon education and experience.

Applications with resume and names and phone numbers of three references should be sent to: Director, Montana Bureau of Mines and Geology, Montana College of Mineral Science and Technology, Butte, MT 59701.

An EEO/AA Employer.

University of Wyoming/Department of Geology and Geophysics. The Department of Geology and Geophysics encourages applications from students interested in pursuing graduate research in the fields of igneous and metamorphic petrology and geochemistry. Current research topics, involving field and laboratory studies, include: island arc and continental volcanics, petrogenesis of granitic and anorthositic rocks, evolution of the Archean crust, petrogenesis of mylonitic rocks, and geothermometry and geobarometry as applied to the evolution of orogenic terranes. Facilities include: an analytical geochemical lab for whole-rock and trace element analysis, a fully automated CAMECA microprobe, two JOEL scanning electron microscopes, a thermal ionization mass spectrometer for analyzing Rb-Sr, Sm-Nd, and U-Th-Pb isotopes, a microthermometry lab, and an experimental petrology lab. Applicants should contact:

Petrology/Geochemistry Program
Department of Geology and Geophysics
PO Box 3006, University Station
University of Wyoming
Laramie, WY 82071.

High Altitude Observatory Scientific Visitor Program/NCAR. Scientific visitor appointments at the High Altitude Observatory are available for new and established Ph.D.'s for up to one year to carry out research in solar physics, solar-terrestrial physics, and related subjects. Applicants should provide a curriculum vitae, including education, work experience, publications, the names of three scientists familiar with their work, and a statement of their research plans. Applications must be received by 15 January 1985 and they should be sent to: The HAO Visitor Committee, High Altitude Observatory, National Center Atmospheric Research, P.O. Box 3000, Boulder, Colorado 80307-3000.

NCAR is an Equal Opportunity/Affirmative Action Employer.

Yale University/Solid Earth Geophysics. The Department of Geology and Geophysics is soliciting applications for a junior faculty position in solid-earth geophysics to begin in the academic year 1985–1986. Areas of interest to the department include seismology, exploration geophysics, mechanical and physical properties of rocks and minerals, geomagnetism, tectonophysics, and geodesy. Curriculum vitae, publications and the names of three or more referees should be sent by December 1, 1984 to Karl K. Turekian, Chairman, Department of Geology and Geophysics, Yale University, Box 6666, New Haven, CT 06511.

Yale University is an equal opportunity/affirmative action employer and encourages applications from all qualified scientists.

Postdoctoral Position/Naval Postgraduate School. The Ocean Turbulence Laboratory has available a postdoctoral position for a person interested in the analysis and interpretation of oceanic turbulence data. The tenure is for one or two years. The successful candidate should have a Ph.D. in physical oceanography and although experience with turbulence data is preferable it is not essential. The opportunity for involvement in data gathering expeditions is also available. Resumes can be sent to Dr. R.G. Lueck, Code 68 Ly, Naval Postgraduate School, Monterey, CA 93943.

AA/EOE.

Ph.D. Scientist I/High Altitude Observatory, National Center for Atmospheric Research. Conducts both independent and collaborative research aimed at understanding a broad variety of solar and related astrophysical phenomena, especially those involving the dynamical behavior of magnetized plasmas. Develops analytical and numerical techniques for the description of macroscopic and microscopic plasma properties and applies these techniques to studies involving theoretical modeling and observational interpretation of the solar interior, solar atmosphere, interplanetary medium, and related astrophysical systems. Should have research experience in theoretical studies of magnetized plasmas. Position available: 9/1/85. Salary: $27,104—$40,656/year. Scientist I appointments are for terms up to three years; individuals may be appointed to the next higher level in accordance with UCAR scientific policy. Applications should be sent to: R. M. MacQueen, HAO, NCAR, PO Box 3000, Boulder, CO 80307-3000.

NCAR is an equal opportunity/affirmative action employer.

Sedimentologist-Oceanographer/Texas A&M University. Applications are invited for a tenure track faculty position in the general field of marine sedimentology. The position will involve graduate level teaching and supervision of graduate student research. The successful applicant will have demonstrated excellence in or a strong potential for independent research in the field of marine sedimentation. The position is available beginning September 1, 1985. Salary and rank will be commensurate with experience and qualifications. Applicants are invited to submit curricula vita, copies of publications, names of three persons who may serve as references, and a brief statement of the applicant's teaching and research interests by December 31, 1984, to Robert O. Reid, Distinguished Professor and Head, Department of Oceanography, Texas A&M University, College Station, Texas 77843.

Texas A&M University is an affirmative action/equal opportunity employer.

Graduate Assistantships in Physics, Space Physics and Atmospheric Sciences. Assistantships are available for graduate students seeking M.S. and Ph.D. degrees in Space Physics, Atmospheric Sciences or Physics, at the University of Alaska. Research areas include both Experimental and Theoretical studies in Space Plasma Physics, Solar Physics, Computational Physics, Radio Physics, Atomic and Molecular Spectroscopy, Atmospheric Optics, Atmospheric Dynamics, Atmospheric Chemistry, Physical Meteorology and Climatology. Thesis research is conducted through the Geophysical Institute. The stipend is $12,000 to $15,000 per year depending on credentials. Students with B.S. degrees in Physics, Atmospheric Sciences, Electrical or Mechanical Engineering are encouraged to apply. For more information, write to Professor J.R. Kan, Head, Department of Space Physics and Atmospheric Sciences, or Professor G. Shaw, Head, Department of Physics, University of Alaska, Fairbanks, Alaska 99701 or call 907-474-7515.

Geochemistry. The University of California, Davis will fill a permanent, tenure track, faculty position at the assistant professor level beginning Fall, 1985. Candidates having interests in isotope geochemistry and/or the geochemistry of economic deposits are especially encouraged to apply but other specialties in geochemistry will be considered. A PhD degree is required. Responsibilities include teaching at the undergraduate and graduate levels, and research in geochemistry.

Applicants should submit complete vita, a statement of research and teaching interests and the names of three referees. Deadline for application is January 15, 1985. Inquiries and applications should be directed to: Dr. Howard W. Day, Department of Geology, University of California, Davis, CA 95616.

The University of California is an equal opportunity/affirmative action employer.

Research Associate/University of Maryland. The Space Physics Group of the Department of Physics and Astronomy has an opening for a Research Associate for an initial one-year period with high likelihood of extension. The position should be research on energetic particles of solar and interplanetary origin. Applicants should possess a Ph.D. in a relevant area of physics or astrophysics; relevant research experience is highly desirable. Inquiries and applications should be addressed to Prof. Glenn M. Mason, Department of Physics and Astronomy, University of Maryland, College Park, MD 20742. Applicants should send a vita including complete bibliography and a description of research experience, and should arrange for the sending of at least three letters of reference.

The University of Maryland is an equal opportunity/affirmative action employer.

College of Geosciences/University of Oklahoma. Applications and nominations are invited for the position of Director of the School of Geology and Geophysics. The Director is expected to have a Ph.D. or equivalent, a strong, ongoing research program and administrative experience; industrial experience helpful; field of geological specialization open; to begin July 1, 1985; salary to be negotiated.

In 1986, the School will move into the new 300,000 sq. ft. Energy Center along with other elements of the College of Geosciences: the Oklahoma Geology Survey; and the School of Petroleum and Geological Engineering and the School of Chemical Engineering and Materials Sciences, both from the College of Engineering.

Applications with curriculum vitae, names and addresses of three references, and/or nominations should be sent to:

Francis G. Stehli, Dean
College of Geosciences
University of Oklahoma
601 Elm Street, Room 438C
Norman, OK 73019.

Consideration of applications will begin January 1, 1985.

The University of Oklahoma is an Equal Opportunity/Affirmative Action Employer.

Manager, Research Computer Facility. The University of Oklahoma is looking for a person to manage a recently purchased VAX 11/785 computing facility dedicated to research in the Geosciences. Hardware and Software are designed for image processing, seismic reflection data processing, and graphical display of geological, geographical and geophysical data.

In addition to the 11/785 with 8mb of CPU memory, the system includes an array processor, five tape drives, five disk drives, a line printer, a 36" electrostatic plotter, and two high resolution graphics work stations with a digitizing board. The image processing hardware includes a Gould-DeAnza IP8500 processor with 16 image memory planes, real time disk memory and three high resolution color monitors.

The person selected must have at least a BS degree in science, math, engineering or related field; two years programming experience including FORTRAN; educational or computing experience in solid earth geophysics or meteorology. Experience with the VAX VMS operating system as well as supervisory experience are desired.

Salary is negotiable. People interested in the position should send a resume, copies of academic transcripts, and the names, addresses and telephone numbers of three references to:

John Wickham, Director
School of Geology & Geophysics
University of Oklahoma
Norman, OK 73019

Applications must be received by November 2, 1984.

Saint Louis University. The Department of Earth and Atmospheric Sciences invites applications for a tenure-track assistant professor position in geophysics effective for the fall of 1985. We seek an individual with broad interests who will complement active research programs in seismology and earth structure. Preference will be given to candidates who can teach existing courses in plate tectonics, geomagnetism and/or geoelectricity. The successful candidate must have a Ph.D. degree and will be expected to maintain an active research program, to teach geophysics courses at the undergraduate and graduate levels, and to supervise graduate student research. The application deadline is January 15, 1985. Applicants should send a curriculum vitae, a statement of research and teaching interest and the names of 4 professional references to:

Dr. Brian J. Mitchell, Chairman
Department of Earth and Atmospheric Sciences
Saint Louis University
PO Box 8099—Laclede Station
St. Louis, MO 63156.

Saint Louis University is an affirmative action/equal opportunity employer.

Civil Engineering. The University of Notre Dame is seeking applications for a tenure track Assistant or Associate Professor position in its Department of Civil Engineering. Applicants should have an earned Ph.D. in Civil Engineering or an appropriately allied discipline; the initiative, scholarship, and creativity to direct a funded research program encompassing M.S. and Ph.D. students; and a demonstrated ability for quality teaching at the graduate and undergraduate levels. The successful candidate will strengthen the Department in at least one of the following areas: water quality, hydrology, environmental chemistry, soil mechanics, geotechnical engineering, design or structural analysis. Appointment will begin with the Fall 1985 semester or other agreed upon date. Send resume and names of three references to: William G. Gray, Chairman, Department of Civil Engineering, University of Notre Dame, Notre Dame, IN 46556.

Affirmative Action/Equal Opportunity Employer.

Faculty Positions in Geochemistry and in Neotectonics. The State University of New York at Binghamton invites applications for tenure track positions in these two areas beginning August, 1985. The appointments will be at the assistant or junior associate professor level and will require completion of the PhD prior to this date. The candidates must demonstrate potential to develop a productive research program as well as teach at the undergraduate and graduate levels.

The geochemist should have primary interests in some aspect of low temperature geochemistry. The neotectonist should have some interest and experience in study of sedimentologic and/or geomorphic processes and products as well as tectonic ones. Applicants should send a resume and names of three persons who can be contacted for references to: J.R. Beerbower, Department of Geological Sciences and Environmental Studies, State University of New York, Binghamton, NY 13901.

The State University of New York is an affirmative action/equal opportunity employer. The closing date for this position is 15 December 1984.

Paleobiology and Quaternary Paleoecology Positions/University of Tennessee. The Department of Geological Sciences, UT Knoxville (main campus), invites applications for two tenure track teaching and research positions at the Assistant Professor level.

(1) *Paleobiologist*—Applicants should have research interests in paleobotany, micropaleontology, or invertebrate paleontology.

(2) *Quaternary Paleoecologist*—Applicants should have research interest in terrestrial floras and/or paleoclimatology. This is a 3/4-time appointment made jointly with the Graduate Program in Ecology.

Both positions will be effective September 1, 1985, and applications are due by January 5, 1985. Ph.D.'s are required. Send resume, transcripts, and names of three referees to: Search Committee, Deparment of Geological Sciences, University of Tennessee, Knoxville, TN 37996.

UTK is an EEO/Title IX/Section 504 employer.

Director: Atmospheric Sciences Research Center/State University of New York at Albany. The State University of New York at Albany invites nominations and applications for the position of Director of the Atmospheric Sciences Research Center. The main purposes of the university-wide center, located adjacent to the main campus of the State University of New York at Albany are, a) to promote and encourage programs of research in basic and applied sciences, especially as these relate to our environment and b) to encourage the fullest possible participation in these research activities by faculty and students throughout the university and in all appropriate industrial, governmental, and educational groups.

Qualifications: Scientists of international reputation having a record of publications relating to atmospheric problems; involvement with research in own field and interest in research being conducted by colleagues; proven ability in administrative skills; desire and aptitude to communicate about science with students and the general public; success in securing funding for research from governmental, industrial, and other agencies.

Inquiries, nominations, or applications with supporting resumes should be directed to John Shumaker, Vice President for Research and Educational Development, State University of New York at Albany, Albany, NY 12222. Application deadline November 15, 1984.

SUNYA is an Affirmative Action/Equal Opportunity employer.

Applications from minority persons, women, handicapped persons and Viet Nam era veterans are especially welcome.

Visiting Appointments/Princeton University. A limited number of one-year visiting appointments, with the possibility of renewal, are available on a competitive basis for new and established Ph.D.'s to carry out research in dynamics and predictability of the atmosphere and oceans, climatology, atmospheric and oceanic chemistry, basic geophysical fluid dynamics, and solid earth geophysics. Successful applicants will have access to the facilities of the Geophysical Fluid Dynamics Laboratory/NOAA. Information and application forms can be obtained from: Chairman, Visiting Scientist Selection Committee, Geophysical Fluid Dynamics Program, Princeton University, P.O. Box 308, Princeton, New Jersey 08542.

Princeton University is an equal opportunity employer—M/F.

Anticipated Petrology/Mineralogy/Volcanology: Louisiana State University. The Department of Geology is searching for candidates to fill positions in metamorphic petrology, economic mineralogy, and volcanology associated with studies of pyroclastics, remote sensing of volcanic landforms, or geophysical interpretation of subsurface volcanic features. Successful applicants are expected to offer graduate and undergraduate courses in their specialties and to develop a strong record of funded research and publications. The positions are at the Assistant Professor level, but appointment at higher rank will be considered for candidates with exceptional ability and appropriate experience.

Major departmental equipment available includes an electron microprobe, SEM, X-ray diffraction, ICP, AA, mass spectrometers, IBM 3081 and 3033 Mainframe computers and Department VAX 11/750, along with a wide variety of microscopes and accessories. Ongoing research related to the above positions includes studies of greenstone belt volcanics, archean sediments, ocean floor and flood basalts, fission-track dating, K-Ar and Ar-Ar, oxygen isotope mass spectrometry, carbonate geochemistry, and clay mineralogy.

Applicants should submit a vita, representative reprints, and a statement of teaching and research interests and arrange for three letters of recommendation to be sent to: Chairman PMV Search Committee, Department of Geology, Louisiana State University, Baton Rouge, LA 70803.

LSU is an equal opportunity/affirmative action employer.

South Dakota School of Mines and Technology. The Department of Geology and Geological Engineering is seeking applicants for a full-time tenure track position in geological engineering beginning fall 1985. Applicants should have a Ph.D. degree or commensurate experience including "Registration" in geotechnical or petroleum engineering or hydrogeology and will be expected to teach at both undergraduate and graduate levels as well as conduct an active research program in their field of specialization.

The Department has an undergraduate enrollment of 200 majors and a graduate enrollment of 60. Field applications are emphasized. Interested persons should send a resume and three letters of recommendation to Alvis Lisenbee, Department of Geology/Geological Engineering, South Dakota School of Mines and Technology, Rapid City, SD 57701.

Deadline for applications is February 1, 1985.

SDSM&T is an equal opportunity employer.

Graduate Fellowships/University of Oklahoma. The School of Geology and Geophysics offers fellowships for Ph.D. study in each of the following broad disciplines: (1) origin, ascent, and fractionation trends in magmas and associated ore deposits; (2) formation and tectonic evolution of continental lithosphere, including geophysical properties and structures of the upper crust; and (3) sedimentary processes, including organic and inorganic diagenesis, evolution of hydrocarbons, and correlation using biostratigraphic methods. Average fellowship stipends are for $10,000/9 month and are renewable annually on a competitive basis. Fellowship awards include a waiver of out-of-state tuition and fees.

The School of Geology and Geophysics presently consists of 19 full-time faculty. Research facilities in the school include a stable isotope laboratory; organic geochemistry laboratory; computer automated X-ray diffraction and fluorescence equipment; atomic absorption and neutron activation analysis equipment; scanning electron microscope with energy dispersive analyzer; transmission electron microscope; fission-track dating laboratory; fluid inclusion microthermometry laboratory; 2 kb hydrothermal laboratory for phase equilibrium experiments; high-pressure rock mechanics laboratory; paleomagnetic laboratory with a cryogenic magnetometer and thermal and AF demagnetization apparatus; 24-, 48-, and 192-channel digital seismic recording systems; a VAX 11-785 computer with high-resolution graphics and image-display terminals, with seismic and image processing software; and a 84,000 volume geology and geophysics library located in the department.

For further information on faculty and active research projects, contact: Kevin Crowley, School of Geology and Geophysics, University of Oklahoma, 830 Van Vleet Oval, Norman, OK 73019.

Structural Geology/Duke University. The Department of Geology invites applications for a senior-level tenured faculty position in structural geology. We are seeking an individual with a proven research record and international recognition in his/her field. The Department has active research programs in geophysics, sedimentology, geochemistry, igneous petrology, carbonate petrology, marine geology and paleontology; graduate programs for both the MS and Ph.D. degrees are offered. Applicants should send a curriculum vitae and names and addresses of six references. The position is to be filled by September, 1985. Closing date for applications and nominations is December 31, 1984. Applications, nominations and inquiries should be directed to Chairman, Search Committee, Department of Geology, Duke University, PO Box 6729 College Station, Durham, NC 27708.

Duke University is an equal opportunity/affirmative action employer.

Sedimentary Geochemist/Geologist. The Department of Geological Sciences at Lehigh University announces the availability of a tenure track position at the Assistant Professor level starting September 1, 1985. The successful candidate will be expected to teach both graduate and undergraduate courses and to maintain an active research program. Primary consideration will be given to those whose research experience and professional interests are in low-temperature sedimentary geochemistry, but outstanding candidates in related research areas will also be considered. The Department of Geological Sciences has nine faculty members and some 35 graduate students. Research facilities include automated XRF and XRD within the department; electron microprobe; analytical SEM, TEM, AA, etc. are available on campus. Respond with a letter describing research interests, full curriculum vita, and the names of three references by December 15, 1984 to: Charles B. Sclar, Chairman, Department of Geological Sciences, Lehigh University, #31 Williams Hall, Bethlehem, Pennsylvania 18015. Applications received after December 15 may not be given full consideration.

Lehigh University is an equal opportunity/affirmative action employer. Women and minorities are especially encouraged to apply.

Coastal Physical Oceanographer. The College of Marine Studies invites applications for a tenure track position in physical oceanography. Applicants should have a background in coastal or estuarine physical oceanography, with experience in observational work at sea. The successful applicant will have the opportunity to develop an independent oceanographic research program which may include carrying out physical oceanographic research within existing interdisciplinary research programs in Delaware Bay or the adjacent continental shelf. Facilities available include the 120-foot coastal research vessel Cape Henlopen. Teaching at the graduate level will be required, and the successful candidate will be expected to develop a funded research program involving graduate students. It is anticipated that the appointment will be at the assistant professor level, but applications from more senior persons are welcome. Applicants should send curriculum vitae, pertinent reprints, and the names of three references to the chairman of the search committee: Dr. Richard Garvine, Oceanography Program, College of Marine Studies, UNIVERSITY OF DELAWARE, Newark, DE 19716. (302) 451-2169. The closing date for applications is November 30, 1984.

The University of Delaware is an equal opportunity/affirmative action employer.

Senior Hydrologist. The Monterey Peninsula Water Management District invites applications for a position of SENIOR HYDROLOGIST. The MPWMD is a small, progressive planning and regulatory agency that deals with problems ranging from designing a new water supply project to groundwater management and riverbank and watershed erosion. The preferred candidate will: have a MS or PhD and three years of work experience; be a generalist, able to deal with both surface and groundwater; be able to do independent research, applying modern techniques to applied problems; be able to communicate effectively with the Board of Directors and the general public. Salary comparable to USGS. The MPWMD is an equal opportunity employer, and hopes to fill the position by January 1985. Send resume to Bruce Buel, General Manager, MPWMD, P.O. Box 85, Monterey, CA 93940.

Seismologist/University of Utah. The Department of Geology and Geophysics at the University of Utah seeks applicants for a tenure track faculty position in seismology at the assistant to associate professor level. Applicants with backgrounds and specialties in seismic imaging, seismic reflection or theoretical seismology will be given preference. The individual will be expected to teach undergraduate and graduate courses and to pursue an active research program with graduate students. A seismic imaging laboratory with a VAX 11/750, FPS array processor, plotters, and processing and synthetic seismogram software is available to the successful candidate. Current research in seismology includes: earthquake research utilizing a PDP 11–70 computer; monitoring of the Intermountain seismic belt by an 85 station telemetered network utilizing an on-line PDP 11–34 computer; major experiments in seismic refraction and reflection profiling for crustal structure; and allied research in tectonophysics. The opportunity exists to participate with several other faculty in an integrated program of tectonics, seismology and sedimentology directed toward crustal studies and petroleum exploration. The geophysics component of the department has active research and teaching programs in electrical and electromagnetic methods, thermal properties of the earth, potential fields, and seismology. The department has close associations with the numerical analysis and data processing groups in computer science, electrical engineering and mathematics. The closing date for applications is December 31, 1984, and the appointment date is September 15, 1985. A Ph.D. is required for this position. Applicants should submit a vita, transcripts, a letter describing his/her research and teaching goals and names of five persons for reference. Applications should be submitted to William P. Nash, Chairman, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112–1183.

The University of Utah is an equal opportunity/affirmative action employer.

University of Arizona/Groundwater Hydrologist. The University of Arizona, College of Engineering, Department of Hydrology and Water Resources, invites applications for a tenure track faculty position at the Assistant or Associate Professor level in groundwater hydrology. Applicants should have a strong background in hydrogeology, groundwater hydraulics, contaminant transport, and groundwater modeling. The position will involve teaching graduate and undergraduate classes and developing a strong research program in one or more of the above areas. Interested persons should send an up-to-date resume and the names of at least three references to:

Dr. Shlomo P. Neuman
Department of Hydrology and Water Resources
University of Arizona
Tucson, Arizona 85721

The University of Arizona is an affirmative action/equal opportunity employer.

Graduate Research in Marine Geochemistry. The Hawaii Institute of Geophysics invites applications from students interested in interdisciplinary programs leading to the M.S. and Ph.D. degrees in Oceanography or Geology/Geophysics. Specific areas of research include: sediment burial diagenesis, sediment-seawater-organism interactions, carbonate sedimentology and geochemistry, isotope and trace metal geochemistry, organic geochemistry, nutrient geochemistry, submarine hydrothermal/geothermal processes including seawater-basalt interactions and mineral genesis, and biogeochemical cycling. Current teaching/research stipends are $6,000-$10,000 for an 11-month appointment in addition to tuition remission. For further information contact:

Dr. Fred T. Mackenzie, Head
Marine Geochemistry Division
Department of Oceanography
Hawaii Institute of Geophysics
1000 Pope Road, MSB 307
Honolulu, HI 96822.

Hydrologist. Monterey, California. $1,887 to $2,293 per month plus benefits. Requires BS in Hydrology, computer programming skills and three years' experience. Apply by 5:00 p.m. November 15, 1984. Send resume to Monterey Peninsula Water Management District, P.O. Box 85, Monterey, California 93940. Call 408-649-4866 for job flyer. EOE.

Texas Tech University/Geophysicist or Clastic Sedimentologist. The Department of Geosciences at Texas Tech University seeks applications for a tenure track position in the fields of geophysics or clastic sedimentology to begin August 1985. Rank and salary will be commensurate with qualifications. The Ph.D. is required. Entry-level applicants will be given preference. The primary responsibility would be to teach both graduate and undergraduate courses in geophysics or depositional systems and sedimentology, his/her specialty and introductory geology. The person will be expected to initiate a research program and to direct MS and Ph.D. graduate students. Send a letter of application with complete curriculum vitae and names of three references to Dr. Alonzo D. Jacka, Chairman of Geosciences, P.O. Box 4109, TTU, Lubbock, TX 79409.

Texas Tech is an equal opportunity/affirmative action employer. Applications deadline: January 31, 1985.

Professor (Research)/Stanford University/Plasma Physics, EM Waves, Space Physics. We are seeking a senior person who has demonstrated scientific, managerial, and leadership qualifications in one or more of the following disciplines: Space Plasma Physics, electromagnetic waves, and solar-terrestrial physics. We expect the successful candidate to have established an outstanding reputation documentable through professional writings or other evidence of personal technical creativity, letters of reference from recognized research leaders in the disciplines mentioned above, and/or awards and other recognition from appropriate professional societies.

It is expected that this individual will develop a research program in one of the disciplines given above working in coordination with ongoing programs within the STAR Laboratory and, possibly, with other activities within the Stanford Center for Space Science and Astrophysics. It is expected that this individual will have a strong background in experimental techniques, either in the laboratory or in the field, including the environment of space; experimental activities in either laboratory or space plasma physics would be regarded as good qualifications. However, close association with theoretical developments in plasma physics and/or electromagnetic theory will clearly be desired. It is also expected that the individual will have a demonstrated capability for securing federal or other research grant support, or be deemed by the selection committee of being capable of securing such funds.

It is anticipated that the person chosen will devote the major part of his or her time to research activities. However, there is an opportunity for participation in academic responsibilities of the Electrical Engineering Department, including, when time permits, teaching graduate and undergraduate classes, serving on various committees of the department, School of Engineering, and the university. It is expected that the person chosen will participate actively in the training of graduate students.

The Chairman of the selection committee for this position is *Professor Robert A. Helliwell, Professor of Electrical Engineering, Space, Telecommunications, and Radioscience Laboratory, Stanford University, Stanford, California 94305.* Other members of the selection committee include Professor P.M. Banks, Professor R.N. Bracewell, Professor L.R.O. Storey, and Professor L. Tyler.

Application deadline is November 15, 1984.

Mathematician (Numerical Analyst)/USDA, Agricultural Research Service. The USDA-ARS, Hydro-Ecosystem Research Unit, Fort Collins, Colorado, has an immediate opening for a Numerical Analyst (GS-1520-12). The Hydro-Ecosystem Research Unit is an interdisciplinary group with scientific and technological research activities in applied soil physics, surface hydrology, groundwater hydraulics, alluvial-stream mechanics, and water and wind-borne migration and dispersion of agricultural pollutants. The major objectives of this Unit include the development and evaluation of large-scale computational models of agricultural ecosystem processes. The site offers excellent working and computer facilities, with ready access to first-rate technical libraries and laboratories, and high-powered scientific computer systems at nearby Colorado State University campus.

The incumbent will provide theoretical, computational and software-design support for the development of large scale computational models. Preferably candidates should have an advanced graduate degree in mathematics, physics, engineering, or an equivalent combination of education/professional experience. The following selective factors will distinguish qualified candidates from those not qualified: Knowledge of FORTRAN language programming and in the application of advanced numerical techniques, including finite difference and finite element methods, to the solution of multi-dimensional boundary-value problems. Knowledge of fluid dynamics and turbulent transport concepts is desirable. Some of the models will be implemented on Cyber-205 computer, so knowledge of vector processing machines is desirable. Skill in written communication for the preparation of technical reports and model documentation is desirable.

This is a permanent Federal Civil Service position. Applicants must be U.S. citizens. Interested persons should send a completed Standard Form 171, College Transcript or a List of College Courses using OPM Form 1170/17, and supporting documents such as names, addresses, and telephone numbers of at least three professional references to the person and address listed below. The above is a summary of the qualifications; applicants may call for further information, application procedures, and necessary forms, or write to:

Cathleen Enston
USDA, Agricultural Research Service
BARC-West, Building 005, Room 107
Beltsville, MD 20705
Telephone: A/C 301-344-3158.
An Equal Opportunity Employer.

Meetings

Announcements

Groundwater Flow Systems

May 27–31, 1985 Saturated/Unsaturated Groundwater Flow Systems: Measurement and Estimation of Parameters, Baltimore, Md. Sponsor: AGU. (James W. Mercer, GeoTrans, Inc., 209 Elden St., Herndon, VA 22070; tel.: 703-435-4400 or Roger B. Clapp, Oak Ridge National Laboratory, PO Box X, Oak Ridge, TN 37831; tel.: 615-576-6619.)

The deadline for abstract submission is February 1, 1985.

A one-day session at the 1985 AGU Spring Meeting will focus on the difficulties of the identification of parameter values, which often constitutes the most costly and time-consuming step in analytic procedures. The first of two topics to be addressed is methods for specifying parameters, both directly by field measurement and indirectly by calibration. The second topic is the problem of how to account for parametric uncertainty in model predictions of water/solute movement. Presentations will include both theoretical inquiries and applications, with an emphasis on the latter.

A WORKSHOP ON ODP DRILLING IN THE N.E. PACIFIC

INPAC (International N.E. Pacific Activities Consortium) announces a workshop to further define a drilling program in the N.E. Pacific using the new ODP drilling ship SEDCO/BP 471, which is scheduled to be in the region in summer 1990. The workshop will take place at the School of Oceanography, University of Washington on February 20–22, 1985. The three-fold focus of the proposed integrated, multi-disciplinary drilling program will include: 1) ridge crest processes on the Juan de Fuca Ridge, 2) convergent margin processes off the Washington, Oregon, and British Columbia coasts, and 3) paleo-oceanography of the N.E. Pacific. The purpose of the workshop will be to further define major scientific problems that can be addressed by drilling, to identify possible drill sites, to present the results of relevant on-going scientific programs in the area, and to organize the data gathering and synthesis necessary to write a comprehensive drilling proposal to JOIDES. The two and one half day workshop is open to all parties who have an interest in the drilling program in the N.E. Pacific. Interested parties should write to the INPAC Committee, c/o Paul Johnson, School of Oceanography WB-10, University of Washington, Seattle, WA 98195, prior to 1 December 1984.

American Museum of Natural History. The Department of Mineral Sciences is seeking to fill a tenure track position for Assistant Curator beginning July 1985. This is mainly a research position, but some time is needed for collections management and departmental activities. High quality sample oriented research and publication is the prime responsibility. The field of specialization is mineralogy, broadly defined, and may include and combine aspects of petrologic mineralogy, ore mineralogy, mineral geochemistry, crystal and thermochemistry, mineral physics, X-ray crystallography, ultrastructure analysis, crystal growth, spectroscopy or gemology. Major research facilities include a fully automated ARL-SEMQ electron microprobe, X-ray laboratory, minicomputer, and vast mineral and other collections. The opportunity exists for research and/or teaching collaboration with nearby institutions such as Columbia (Lamont-Doherty Geological Observatory).

Requirements are a Ph.D. in hand by the time of appointment and an ability to carry out a research program. It is expected that some research support will be sought outside the Museum. Applications should include: (1) a curriculum vitae, (2) names of three persons familiar with your work, and (3) a statement of research interests and specific projects to be carried out within the next five years.

These must be submitted by November 15, 1984 to:

Martin Prinz
Chairman, Search Committee
Department of Mineral Sciences
American Museum of Natural History
New York, NY 10024

An equal opportunity (M/F/H) affirmative action employer.

POSITIONS WANTED

Geologist/Geochemist. 33, M.A., Ph.D. 1983. Specializing in low temperature geochemistry and geochronology with extensive experience in Rb-Sr mass spectrometry. Several publications. Seeks industry, academic research, or government position. Box 027, American Geophysical Union, 2000 Florida Avenue N.W., Washington, DC 20009.

Aerodynamics, Fluid Mechanics, and Hydraulics

June 3–6, 1986 Advancements in Aerodynamics, Fluid Mechanics, and Hydraulics, Minneapolis, Minn. Sponsors: Aerospace, Engineering Mechanics, and Hydraulic divisions of the American Society of Civil Engineers, AGU. (H. Stefan, St. Anthony Falls Hydraulic Laboratory, Department of Civil and Mineral Engineering, Mississippi River at Third Ave., S.E., Minneapolis, MN 55414; telephone: 612-373-2782.)

The deadline for abstracts is March 1, 1985.

The intent of the conference is to summarize advances made in recent years in civil engineering applications of aerodynamics, fluid mechanics, and hydraulics and to allow workers in these areas to interact and discuss new ideas. Suggested topics for sessions and papers include architectural aerodynamics, wind tunnel modeling, military hydrology, wind energy, hydrodynamic loading, stratified flows, drag reduction, remote sensing, and river mechanics. A few honors lectures will be given by invited speakers. Papers that review recent advances in the science, art, and knowledge of the various facets of aerodynamics, fluid mechanics, and hydraulics will be especially welcome.

A field trip to the St. Anthony Falls Hydraulic Laboratory is planned for the day following the conference.

AGU Fall Meeting ASLO Winter Meeting

Session Highlights

ASLO

Sediment-Water Exchange These sessions will include talks concerning the importance of benthic fluxes and material balances, the effects of bioturbation and macrofaunal irrigation on exchange rates, mechanisms of transport through boundary layers, instrumentation for measuring benthic fluxes, and seasonal variability in benthic fluxes.

Larval Ecology and Physiology *December 3, 1315h* This session will focus on feeding, growth, energetics, dispersal, and recruitment of invertebrate and vertebrate pelagic larvae. New methodologies will be demonstrated for studying the ecology of early life histories.

Arctic/Subarctic Limnology *December 3, 0830h* An arctic lake and river have been modified experimentally by changing the nutrient input rates and, for the lake, by changing the predation rate of fish. This allowed tests of questions about the control of ecosystem structure and function through the predators at the top of the food web and through the primary producers at the bottom of the food web. The session papers describe results of studies of chemical and biological processes, ranging from algal species and photosynthesis to nutrient regeneration from the sediments.

Dynamics of Bio-Optical Interactions *December 4, 1400h* Upper ocean optical variability is influenced by biological and physical forcing. These interactions are the subject of observational and modeling studies.

Seismology

The sessions on **Nature and Evolution of the Continental Lithosphere** and **Nature and Evolution of the Oceanic Lithosphere** include a number of papers in a combined oral/poster format. Approximately 10 papers in each session will be presented both as an oral paper in the morning session and as a poster paper in a session the same afternoon with the same authors. The corresponding afternoon oral session will be recessed early (approximately 3:30) to allow ample time for visiting the posters, which will be on display all afternoon in the Main Arena near the exhibits and refreshments. This format is designed for papers requiring large displays (maps, seismic sections, images) and should provide an excellent opportunity to fully appreciate such material.

Special sessions are planned on **Deep Earth Structure.** The morning session will focus primarily on vertical structure in regions such as the core mantle boundary and the upper mantle from body wave data. The afternoon session will include lateral heterogeneity from surface wave and normal mode studies and their implications for mantle flow.

SPR: Magnetospheric Physics

The Magnetospheric Physics Section will be sponsoring several special sessions at the 1984 Fall Meeting. Two papers commemorate the significant works of Neil Brice and Alfred Zmuda. New and interesting results will be presented on planetary magnetospheres, the earth's magnetopause, ULF wave-particle phenomena, lightning VLF/electron precipitation, plasma sheet, and auroral dynamics. Special poster sessions will display plasma theories applicable to auroral and magnetospheric processes. Results from shuttle-borne experiments will be presented. In addition, the results from the recent barium release just outside the magnetopause will be summarized in the AMPTE talks. Mike Temerin and Rick Chappell organized the auroral and space lab sessions.

Tectonophysics

John C. Jamieson Memorial: High-Pressure Geophysics *December 4, 0800h* A special session on high-pressure/high-temperature research has been organized as a posthumous tribute to John C. Jamieson. In his career at the University of Chicago, Jamieson contributed a wealth of knowledge to the geosciences. His developments in high-pressure X ray crystallography led to an extensive catalog of phase relations and crystal structures of materials at high pressure and temperatures. It is fitting that the Tectonophysics and VGP Sections combine to offer this memorial session stressing advances in this area. In addition to a review of Jamieson's efforts, additional reviews of recent advances in high-pressure crystallography, shock wave studies, and general high-pressure techniques will be presented. An abundance of excellent contributed papers cover physical properties of materials at high pressures, phase equilibria, and equation of state studies, melt physics, electrical conductivity, and high-pressure chemistry.

Targets for Continental Scientific Drilling *-December 5, 0800h* Two sessions consisting of a total of 26 papers present the scientific rationale for drilling as a method for addressing fundamental geological problems. The first session concentrates on drilling to study the physical and chemical processes associated with active faulting and geothermal systems. The second session focuses on drilling to recover samples at critical locations for the testing of competing geological processes.

Meeting Report

SPAN Pilot Project Report

Nearly 40 scientists, space physics data system managers, and NASA Headquarters personnel, all members of the Data System Users Working Group (DSUWG), met at Marshall Space Flight Center (MSFC) on May 2 and 3, 1984, to discuss the status and future direction of the Space Physics Analysis Network (SPAN) pilot project. SPAN was recently established by Code EI and Code T at NASA Headquarters as a pilot project based on the recommendations of the DSUWG (see *Eos*, February 7, 1984, p. 46) and the urging of many scientists of the space plasma physics community. SPAN will use as its foundation the SCAN (Space-Plasma Computer Analysis Network) system managed by Marshall Space Flight Center. Code EE at headquarters has chartered the DSUWG, currently chaired by D. N. Baker of Los Alamos, to provide the scientific user guidance for the future development of the SPAN. SPAN will continue to be managed by MSFC but funding and policy review will be handled by Code EI to coordinate all the headquarters space science activities on the system.

The DSUWG subgroups include policy, networking, software, and data base management. The main thrust of the subgroup discussions at the meeting were to begin to document a set of guidelines that will enable other space physics institutions to gain access to the network and to list concerns and suggested solutions for using the system for correlative space science. The proposed document will state the minimum hardware and software requirements to get access to the system, establish guidelines for network use, and discuss the available facilities on the network (which will include large new technology data storage systems, large mainframe computer facilities for modeling, and computer network gateways). Other subgroup topics include the establishment of a standard network graphics metafile format for scientific graphics exchange and use of commercial data base management systems for space science data. It is anticipated that the SPAN document will be completed by the next DSUWG meeting which will be held at Stanford University on November 30 and December 1, 1984.

The status of the network was reported by Dave Peters of MSFC (SPAN network manager). SPAN uses electronic computer-to-computer communication to allow users access to distributed solar-terrestrial data taken by instruments on free flying spacecraft, shuttle spacelab, and ground-based facilities. SPAN also allows for the electronic transfer of documentation and mail. SPAN presently connects over 16 computers nationwide at university and government locations such as MSFC, GSFC, Los Alamos, Southwest Research Institute, University of Texas at Dallas, Stanford, Utah State University, Applied Physics Laboratory, and others. The planned near-term additions of institutions on SPAN include National Center for Atmospheric Research, Jet Propulsion Laboratory, TRW, APL, University of California at San Diego, Lockheed, University of Washington, Air Force Geophysical Laboratory, and the Spacelab Mission Integrated Planning System (MIPS). Future use of SPAN by investigators on the CRRES mission was also briefly discussed.

SPAN is developing as a test bed for the design of data systems for future projects. As discussed by M. Wiskerchen (NASA Headquarters), the ISTP program will rely heavily on SPAN as an easy means of exchanging data and textual information for correlative analysis.

D. Baker (Los Alamos) discussed how a substorm workshop using SPAN is being organized for the summer of 1985. The workshop will use data from IMP 7 and 8, Dynamics Explorer 1 and 2, and ISEE 3 (renamed ICE or International Comet Encounter) while it was in the deep tail in late 1982 and early 1983. This extensive workshop will be the first test of similar data sets and systems that will be obtained for the ISTP project in the early 1990's. Not only will a unique set of correlative observations be scientifically examined, but there will also be the identification of the technical problems that must be overcome for a successful data analysis system to be developed for the ISTP mission.

Another proposed use of SPAN may occur for the ICE spacecraft encounter of comet Giacobini-Zinner in September 1985. R. Zwickl (Los Alamos) discussed how near real-time data from the encounter could be networked to LANL, TRW, and possibly JPL and the University of Iowa for processing. The processed data can be returned quickly to GSFC through SPAN where PI's would have the opportunity to analyze and correlate their results with other experiments on the spacecraft within hours of the encounter. Tests of the SPAN system for ICE data transfer are being planned by the ISEE project office to take place this summer.

Other SPAN activities currently in progress were discussed by J. Green (MSFC). Shuttle orbital environment information, which is of vital interest to all Spacelab investigators, is being collected on a GSFC computer that is connected to the SPAN system. Rapid communication between investigators and the Shuttle Environment Information data base is a key element to this project as it is being developed. At the completion of the project, SPAN will be able to provide users with easy access to this information data base.

In addition, it is anticipated that the MSFC Mission Integrated Planning System (MIPS) will be interfaced into SPAN within the next few months. The addition of the MIPS to SPAN will enhance Spacelab pre-mission planning, provide shorter turnarounds, improve communication between Spacelab users and planners, save manpower in the long run, and start the automation of the Spacelab mission planning process at the investigation level. MIPS also provides information by means of the mission timeline regarding when other experiments are operating and in what mode. This information is essential in order to determine when one experiment affects the environment that another experiment is measuring. Complete and up-to-date timeline information will be essential for many of the science dedicated missions, such as Space Plasma Laboratory.

The SPAN system will be augmented by the addition of computers at the newly reorganized National Space Science Data Center (NSSDC) at Goddard Space Flight Center. The inclusion of the NSSDC facilities into a computer network for space scientists was recommended to NASA earlier this year by the National Academy of Sciences CSSP/CSTR data panel. J. King (NSSDC) discussed efforts that are already underway for the development of an online data catalog and data library by using an existing GSFC node on SPAN until facilities are installed at the NSSDC later this year. The NSSDC is forming an ad hoc steering committee, made up of science users, which will provide guidance in the development of the online data directory and catalogue. The online data directory and catalogue, as a first step, is being designed to provide a fast and easy method of obtaining information on the storage, access, and distribution of solar-terrestrial data. V. Abreu, R. Anderson, B. Clauer, R. Gold, B. Theis, and others from the DSUWG volunteered to become part of this steering committee.

This meeting report was prepared by J. L. Green *Space Science Lab., NASA Marshall Space Flight Center, Huntsville, AL 35812.*

Career and Family: Making It Work

AGU Fall Meeting
Wednesday, December 5
6:00-8:00 P.M.
Crystal Ballroom
San Franciscan Hotel

Connie Sancetta of Lamont-Doherty Geological Observatory will moderate a discussion of how best to balance active involvement in a career with having and raising children. Panelists will be Tanya Atwater (University of California, Santa Barbara), Suzanne Beski-Diehl (Michigan Technological University), Laurie Brown (University of Massachusetts) and Sylvia Garzoli (Lamont-Doherty Geological Observatory).

This program has been arranged by the AGU Education and Human Resources Committee. Refreshments will be available.

Geophysical Year

A date at the end of an entry indicates the issue of *Eos* in which a full meeting announcement was run.

A list of abbreviations used in the Geophysical Year calendar appears at the end of the calendar.

Future AGU Meetings:

Fall Meetings

Dec. 3–7, 1984, San Francisco, California

Dec. 9–13, 1985, San Francisco, California *(Abstracts due mid-September 1985)*

Dec. 8–12, 1986, San Francisco, California

Spring Meetings

May 27–31, 1985, Baltimore, Maryland *(Abstracts due early March 1985)*

May 19–23, 1986, Baltimore, Maryland

Regional Meetings

Front Range Branch Symposium on Geophysics and Geology of Yellowstone October 25, 1984, Golden, Colorado

Front Range Branch Hydrology Days April 16–18, 1985, Fort Collins, Colorado *(Abstracts due December 31, 1984 for professional hydrologists; February 15, 1985 for students)*

Chapman Conferences

Solar Wind-Magnetosphere Coupling February 12–15, 1985, Pasadena, California *(Abstracts due November 1, 1984)*

Ion Acceleration in the Ionosphere and Magnetosphere, June 3–7, 1985, Boston, Massachusetts.

Magnetotail Physics, October 28–31, 1985, Laurel, Maryland.

1984

Oct. 24–26 Engineering and Economic Assessment of **Geothermal Resources**, San Francisco, Calif. Sponsor: Geothermal Resources Council. (Grace Mata, Geothermal Resources Council, P. O. Box 1350, Davis CA 95617–1350; tel.: 916-758-2360.)

Oct. 24–26 Nature of the **Lower Continental Crust**, London, England. Sponsors: Geological Society, Royal Astronomical Society, Wegener Foundation. (Geological Society, Burlington House, Piccadilly, London W1V 0JU, England.)

Oct. 25 Symposium on the **Geophysics and Geology of Yellowstone**, Golden, Colo. Sponsors: AGU Front Range Branch, USGS, Cooperative Institute for Research in Environmental Sciences, U.S. Park Service, Colorado School of Mines. (Jo Ann Joselyn, Secretary, AGU Front Range Branch, NOAA/SESC, R/E/SE2, 325 Broadway, Boulder, CO 80303, tel.: 303-497-5147.) (Sept. 18, 1984.)

Oct. 28–30 15th **Underwater Mining Institute**, Madison, Wis. (J. Robert Moore, Program Chairman, Univ. of Texas at Austin, Marine Science Institute, 200 East 26 1/2 St., Austin, TX 78705; tel.: 512-471-4816.) (July 17, 1984.)

Oct. 29–30 Conference on Methods for Evaluation of **Groundwater Contamination Sites**, East Lansing, Mich. Sponsors: Michigan Dept. of Natural Resources, Michigan State Univ., USGS. (David Hamilton, Michigan Dept. of Natural Resources, Stevens T. Mason Bldg. Box 30028, Lansing, MI 48909.) (July 31, 1984.)

Oct. 29–31 Conference on **Geopotential Research Mission (GRM)** Science, College Park, Md. Sponsor: NASA. (L. Walter, Code EE-8, NASA Headquarters, Washington, DC 20546; tel.: 202-453-1675.) (July 24, 1984.)

Oct. 29–31 Symposium on **Groundwater: The Unseen Crisis**, Austin, Tex. Sponsors: Texas A & M University, University of Texas at Austin. (Ernest T. Smerdon, Center for Research in Water Resources, The Univ. of Texas at Austin, Bldg. 119, 10100 Burnet Road, Austin, TX 78758–4497; tel: 512-835-3112.) (Aug. 14, 1984.)

Oct. 29–31 Symposium on **Lunar Bases and Space Activities** of the 21st Century, Washington, D.C. Sponsor: NASA. (Michael Duke, NASA Johnson Space Center, Houston, TX 77058; tel.: 713-483-4464.) (July 24, 1984.)

Oct. 30–Nov. 3 Symposium on Relationships Between **Climate of China and Global Climate**—Past, Present, and Future, Peking, China. Sponsors: Academia Sinica, IAMAP, AMS. (Jih-Ping Chao, Institute of Atmospheric Physics, Academia Sinica, Beijing, China.) (March 27, 1984.)

Oct. 31–Nov. 7 **Regional Assembly of IASPEI**, Hyderabad, India. (Mohan L. Gupta, Organizing Committee, IASPEI Regional Assembly, National Geophysical Research Institute, Hyderabad-500 007, India; telex: 155–478 NGRI IN; cable: Geophysics.) (Aug. 23, 1983.)

Nov. **Mexican Geophysical Union Annual Meeting**, La Paz, Baja California Sur, Mexico. (Unión Geofísica Mexicana, A.C., Comité Organizador Reunión 1984, Apartado Postal 1805, Ensenada 22800. B.C.N. Mexico.) (July 3, 1984.)

Nov. 5–8 **GSA Annual Meeting**, Reno, Nev. (Jean Latulippe, GSA, P. O. Box 9140, Boulder, CO 80301; tel.: 303-447-2020.)

Nov. 5–9 13th **Scientific Meeting of Geophysicists and Geodesists**, San Carlos de Bariloche, Argentina. Organizer: Argentine Association of Geophysics and Geodesy. (Lic. Francisco Hirsch, Asociación Argentina de Geofísicas y Geodestas, Casilla de Correo 106, Sucursal 28, (1428) Capital Federal, Argentina.) (Oct. 10, 1984)

Nov. 8–9 **Illinois Lake and Watershed Management Conference**, Springfield, Ill. Sponsors: Univ. of Illinois Water Resources Center, AWRA Illinois section, North American Lake Management Society. (Glenn Stout, Water Resources Center, Univ. of Illinois at Urbana-Champaign, 2535 Hydrosystems Laboratory, 208 North Romine St., Urbana, IL 61801; tel.: 217-333-0536.) (June 12, 1984.)

Nov. 11–16 Engineering Foundation Conference on **Groundwater Contamination**, Santa Barbara, Calif. Sponsors: The Engineering Foundation, Universities Council on Water Resources. (Engineering Foundation, 345 E. 47th St., New York, NY 10017; tel.: 212-705-7835.)

Nov. 12–17 First Symposium on the **Humid Tropics**, Belém, Pará-Brasil. Sponsors: Brazil-

Meetings (cont. on p. 778)

Meetings (cont. from p. 777)

Ian Agricultural Research Organization, the Center for Agricultural Research on the Humid Tropics. (Secretaria do 1º Simpósio do Trópico Úmido, Centro de Pesquisa Agropecuária do Trópico Úmido-CPATU, Caixa Postal 48, 66000—Belém, Pará-Brasil; tel: 091-226-6022; telex: 91121.) (July 31, 1984.)

Nov. 12–17 Water for South Africa, Johannesburg, South Africa. Sponsors: NWWA, Borehole Water Assoc. of Southern Africa. (David M. Nielsen, Conference Coordinator, NWWA, 500 W. Wilson Bridge Rd., Worthington, OH 43085; tel.: 614-846-9355.) (Dec. 13, 1983.)

Nov. 13 Conference on Water Reuse and Desalination, Johannesburg, South Africa. Sponsor: NWWA. (Pat Alcorn, NWWA, 500 W. Wilson Bridge Rd., Worthington, OH 43085; tel.: 614-846-9355.) (May 29, 1984.)

Nov. 13–14 Symposium on Geophysics in Kansas—A 25-Year Update, Wichita, Kan. Sponsors: Kansas Geological Survey, University of Kansas. (Conferences and Special Programs, University of Kansas, Continuing Education Building, Lawrence, KS 66045–2607.) (Oct. 16, 1984.)

Nov. 13–15 Ophiolites Through Time, Nancy, France. (Jacqueline Desmons, Université de Nancy I, Faculté des Sciences, Laboratoire de Pétrologie, B.P. No. 239, F-54506 Vandoeuvre-lès-Nancy Cedex, France.) (June 26, 1984.)

Nov. 13–15 1984 International Symposium on Antennas, (Journées Internationales de Nice sur les Antennes—JINA), Nice, France. Organizers: France's Centre National d'Études des Télécommunications (CNET), Société des Électriciens, des Électroniciens et des Radioélectriciens. (Secrétariat JINA '84, CNET-PAB, Centre de la Turbie, 06320 Cap d'Ail, France.) (Aug. 14, 1984.)

Nov. 13–15 Coastal Zone and Continental Shelf Conflict Resolution, Cambridge, Mass. Sponsor: Massachusetts Institute of Technology Sea Grant Program. (Elizabeth T. Harding, MIT Sea Grant Program, 77 Massachusetts Ave., Bldg. E38, Cambridge, MA 02139; tel.: 617-253-3401.)

Nov. 19–23 12th World Mining Congress, New Delhi, India. Sponsor: The Institution of Engineers (India). (The Institution of Engineers (India), 8 Gokhale Road, Calcutta 700020, India, or The Institution of Engineers (India), SIII State Center, B. Shah Zafar Marg 110002, New Delhi, India.)

Nov. 20–21 7th International Symposium on Wastewater Treatment, Montreal, Canada. Organizers: Environment Canada, Société Québécoise d'assainissement des eaux, Association Québécoise des techniques des eaux. (Alain Jolicoeur, Environment Canada; tel.: 819-997-3405; or Claude Vergès, LAB-TEQ/Sonexeau, AQTE Representative; tel.: 514-636-5025.) (Oct. 16, 1984.)

Nov. 20–30 WMO Technical Conference on Urban Climatology and Its Applications With Special Regard to Tropical Areas, Mexico City. Sponsors: WMO, World Health Organization. (T. R. Oke, c/o World Climate Program Dept., WMO, 41, Giuseppe-Motta, Case postale No. 5, CH-1211 Geneva 20, Switzerland.) (June 12, 1984.)

Nov. 26–30 Symposium on the Scientific Basis for Nuclear Waste Management, Boston, Mass. Sponsor: Materials Research Society. (John Stone, E. I. du Pont de Nemours and Co., Savannah River Laboratory, Aiken, SC 29808.) (May 8, 1984.)

Nov. 27–30 Thirtieth Annual Conference on Magnetism and Magnetic Materials, San Diego, Calif. Sponsors: American Institute of Physics, Magnetics Society of Institute of Electrical and Electronics Engineers. (John Scott, American Institute of Physics, 335 East 45 St., New York, NY 10017.) (June 5, 1984.)

Nov. 30–Dec. 1 NASA/Lunar and Planetary Institute Workshop on Water on Mars (part of Mars: The Evolution of its Climate and Atmosphere), Moffett Field, Calif. (NASA/LPI Project Office, 3303 NASA Road 1, Houston, TX 77058.) (Sept. 4, 1984.)

Dec. 3–7 AGU Fall Meeting, San Francisco, Calif. (Meetings, AGU, 2000 Florida Ave., N. W., Washington, DC 20009.)

Dec. 16–21 International Chemical Congress of Pacific Basin Societies, Honolulu, Hawaii. Sponsors: ACS, Chemical Institute of Canada, Chemical Society of Japan. (PAC CHEM '84, Meetings and Divisional Activities Dept., ACS, 1155 16th St., N. W., Washington, DC 20036; tel.: 202-872-4396; PAC CHEM '84, Chemical Institute of Canada, 151 Slater St., Suite 906, Ottawa, Ontario K1P 5H3, Canada; tel.: 613-233-5623; PAC CHEM '84, Chemical Society of Japan, 1–5, Kanda-Surugadai, Chiyoda-ku, Tokyo 101, Japan; tel.: 03-292-6161.) (Sept. 13, 1983.)

Dec. 17–21 Tectonic Studies Group 15th Annual General Meeting, Swansea, U.K. Sponsor: University College of Swansea. (Richard Lisle, Dept. of Geology, University College, Swansea SA2 8PP, United Kingdom.)

Dec. 26–31 Fourth International Conference on Applied Numerical Modeling, Tainan, Taiwan. (S. Y. Wang, School of Engineering, Univ. of Mississippi, University, MS 38677; tel.: 601-232-7219.)

1985

Jan. 7–12 17th International Congress on Hydrogeology of Rocks of Low Permeability, Tucson, Ariz. Sponsors: International Assoc. of Hydrogeologists, AGU. (E. S. Simpson, Dept. of Hydrology and Water Resources, College of Engineering, Univ. of Arizona, Tucson, AZ 85721.)

Jan. 7–11 International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, Los Angeles, Calif. Sponsor: AMS. (G. Stanley Doore, Office of the Federal Coordinator, 11426 Rockville Pike, Suite 300, Rockville, MD 20852; tel.: 301-443-8704.) (Aug. 14, 1984.)

February International Symposium on Recent Crustal Movement, Maracaibo, Venezuela. Sponsor: IAG. (Heinz Henneberg, Apartado 6, Maracaibo, Venezuela; telex: 61263 CAMER VC.)

Feb. 4–6 National Conference on Water Resources Research, Chevy Chase, Md. Sponsor: Universities Council on Water Resources. (William L. Powers, Executive Secretary, Universities Council on Water Resources, 310 Agricultural Hall, University of Nebraska, Lincoln, NE 68583-0711; tel.: 402-472-3305.)

Feb. 6–7 USGS Forum on Research in Mineral Resources, Denver, Colo. (William R. Miller, USGS, P. O. Box 25046, Mail Stop 912, Denver Federal Center, Denver, CO 80225; tel.: 303-236-5558.)

Feb. 10–15 Australian Physical Oceanography Conference, Hobart, Tasmania. Convenor: Eric J. Lindstrom. (Eric Lindstrom, CSIRO Marine Laboratories, GPO Box 1538, Hobart, Tasmania, Australia 7001.) (Sept. 4, 1984.)

Feb. 12–15 Chapman Conference on Solar Wind-Magnetosphere Coupling, Pasadena, Calif. (AGU, 2000 Florida Ave., N. W., Washington, DC 20009.)

Feb. 23–24 International Erosion Control Association 16th Annual Conference and Trade Show, San Francisco, Calif. (International Erosion Control Assoc., P. O. Box 807, Freedom, CA 95019.)

Feb. 26–28 Second Hydrology Symposium on Surface Coal Mining in the Northern Great Plains, Gillette, Wyo. Sponsor: Gillette Area Groundwater Monitoring Organization. (Ron Landers, Carter Mining Company, P. O. Box 3007, Gillette, WY 82716; tel.: 307-682-8881.) (July 24, 1984.)

Spring International Symposium on Tropical Hydrology, San Juan, Puerto Rico. Organizer: American Water Resources Association. (Ferdinand Quinones, U.S. Geological Survey, WRD, GPO Box 4424, San Juan, PR 00936; tel.: 809-753-4690.) (Oct. 16, 1984.)

March 10–15 American Society of Photogrammetry and American Congress on Surveying and Mapping Annual Meeting, Washington, D. C. (Willard A. Kuncis, 4415 Jensen Pl., Fairfax, VA 22032; tel.: 703-425-8790.)

March 11–15 16th Lunar and Planetary Science Conference, Houston, Tex. Sponsors: Lunar and Planetary Institute, AGU, NASA Johnson Space Center, Division for Planetary Sciences of the American Astronomical Society, GSA, Meteoritical Society. (Pamela Jones, Conference Administrator, Lunar and Planetary Institute, 3303 NASA Road 1, Houston, TX 77058; tel.: 713-486-2150.)

March 18–21 International Conference on Integral Methods in Science and Engineering, Arlington, Tex. Sponsor: Univ. of Texas at Arlington. (Fred R. Payne, A. E. Dept., Univ. of Texas-Arlington, 76019; tel.: 817-273-2074.) (July 24, 1984.)

April 1–4 Workshop on the Correction of Precipitation Measurements, Zurich. Organizers: Swiss Federal Institute of Technology, International Association of Hydrological Sciences, World Meteorological Organization. (Boris Sevruk, Hydrology Section, Department of Geography ETH, Winterthurerstrasse 190, 8057 Zürich, Switzerland.)

April 1–4 European Union of Geosciences Biennial Meeting, Strasbourg, France. (Organizing Committee, Dept. of Earth Sciences, Univ. of Cambridge, Downing St., Cambridge CB2 3EQ, U.K.)

April 14–19 CSA Penrose Conference on Geomorphic and Stratigraphic Indicators of Neogene-Quaternary Climatic Change in Arid and Semiarid Environments, Lake Havasu City, Ariz. Conveners: John Dohrenwend, USGS; Steve Wells and Les McFadden, Univ. of New Mexico. (John Dohrenwend, USGS, Mail Stop 941, 345 Middlefield Rd., Menlo Park, CA 94025.)

April 15–19 First International Symposium on Precise Positioning with the Global Positioning System, Rockville, Md. Sponsors: IAG, IUGG, Defense Mapping Agency, NOAA. (Positioning with GPS-1985, White Flint Mall, Post Office Box 2095, Kensington, MD 20895.)

April 15–19, 1985 Second International Symposium on Analytical Chemistry in the Exploration, Mining, and Processing of Materials, Pretoria, South Africa. Sponsor: International Union of Pure and Applied Chemistry. (The Symposium Secretariat S.328, CSIR, Box 395, Pretoria, 0001 South Africa.)

April 16–18 Fifth Annual AGU Front Range Branch Hydrology Days, Fort Collins, Colo. (H. J. Morel-Seytoux, Dept. of Civil Engineering, Colorado State Univ., Fort Collins, CO 80523; tel.: 303-491-5448 or 8549.) (July 24, 1984.)

April 18–20 Continental Extensional Tectonics, Durham, England. Sponsor: Geological Society. (J. F. Dewey, Dept. of Geological Sciences, Durham University, Durham DH1 3LE, England.)

April 19 Lithoprobe Phase I, Vancouver Island, Subduction and Accretion Processes, Victoria, B. C., Canada. Sponsors: Geological Assoc. of Canada, Canadian Geophysical Union. (E. Irving, Pacific Geoscience Centre, Box 6000, Sidney, B. C. V8L 4B2, Canada, or R. Clowes, Geophysics and Astronomy, Univ. of British Columbia, Vancouver, B.C. V6T 1W5, Canada.)

April 23–25 Third International Symposium on the North American Vertical Datum, Rockville, Md. Sponsors: AGU, IAG, NOAA, National Geodetic Survey. (Gary M. Young, Asst. Director, NAVD Symposium 85, White Flint Mall, P. O. Box 2095, Kensington, MD 20895; tel.: 301-443-8567.)

April 28–May 1 International Conference on Arctic Water Pollution Research: Applications of Science and Technology, Yellowknife, Northwest Territories, Canada. Organizer: Canadian National Committee, International Assoc. on Water Pollution Research and Control. (K. Charlwood, National Research Council of Canada, Montreal Road Laboratories, Ottawa K1A 0R6, Canada; tel.: 613-993-9009.) (July 10, 1984.)

April 30–May 1 Symposium on Watershed Management, Denver, Colo. Sponsor: ASCE. (E. Bruce Jones, President, Resource Consultants, Inc. P. O. Box Q, Fort Collins, CO 80522.) (May 1, 1984.)

May Symposium on Hydrothermal Alteration and Geothermal Brine Chemistry, Processing, and Mineral Recovery, Palm Springs, Calif. Sponsor: Geothermal Resources Council. (Grace Mata, Geothermal Resources Council, P. O. Box 1350, Davis, CA 95617–1350; tel.: 916-758-2360.)

May 6–10 Symposium on Vertical Motion in the Equatorial Upper Ocean and its Effects on Living Resources and the Atmosphere, Paris, France. Sponsors: Scientific Committee on Oceanic Research, UNESCO. (David Halpern, NOAA PMEL, 7600 Sand Point Way, N. E., Seattle, WA 98115.)

May 7–10 Symposium on Arctic Rifting Styles: Structure, Calgary, Alberta, Canada. Sponsor: International Lithosphere Program. (John W. Pierce, Petro-Canada Resources, PO Box 2844, Calgary, Alberta T2P 3E3, Canada.)

May 13–18 Third JECSS (Japan and East China Seas Study) Workshop, Tsukuba Univ., Japan. Sponsors: Japan Marine Science and Technology Center, Oceanographical Society of Japan, Japanese-French Oceanographical Society. (Takashi Ichiye, Dept. of Oceanography, Texas A & M Univ., College Station, TX 77843.)

May 19–24 2nd U.S.-Dutch International Symposium: Aerosols, Williamsburg, Va. Organizer: U.S. Environmental Protection Agency. (Si Duk Lee, U.S. Coordinator, 2nd U.S.-Dutch International Symposium: Aerosols, U.S. Environmental Protection Agency (MD-52), Research Triangle Park, NC 27711.)

May 27–31 AGU Spring Meeting, Baltimore, Md. (Meetings, AGU, 2000 Florida Ave., N. W., Washington, DC 20009.)

May 27–31 Density Distribution of the Lithosphere: Static and Dynamic Models, Zürich. Organizer: International Association of Geodesy. (J. Bartholomew, Institut für Geodäsie und Photogrammetrie, HPV G 53, ETH-Hönggerberg, 8093 Zürich, Switzerland.)

May 27–June 1 Fifth International Coral Reef Congress, Tahiti, French Polynesia. (Organizing Committee, Coral Reef Congress, B.P. 562 Papeete, Tahiti, French Polynesia.)

Summer Colloquium on Comparative Study of Magnetospheric Systems, France. (Dominique Le Quéau and Benoît Moolker-Pedersen, DASOP, Observatoire de Meudon, F 92195, Meudon Principal Cedex, France; Telex: 200 590 CNET OBS.) (Aug. 9, 1983.)

June Second International Conference on Soil Dynamics and Earthquake Engineering, on board the Queen Elizabeth II. Sponsor: Computational Mechanics Institute. (C. A. Brebbia, Computational Mechanics Institute, Ashurst Lodge, Ashurst, Southampton SO4 2AA England.)

June 3–7 Symposium on Stochastic Approach to Subsurface Flow, Fontainebleau, France. Sponsors: GRECO Hydrogeology of the Centre National de la Recherche Scientifique, Paris School of Mines. (G. de Marsily, GRECO Hydrogéologie, École des Mines de Paris, Centre d'Informatique Géologique, 35, rue Saint-Honoré, 77305 Fontainebleau Cédex, France; tel.: 6-422-48-21.) (Oct. 16, 1984.)

June 3–7 AGU Chapman Conference on Ion Acceleration in the Ionosphere and Magnetosphere, Boston, Mass. (AGU Meetings, 2000 Florida Ave., N. W., Washington, DC 20009.)

June 4–7 International Conference on Mafic Dyke Swarms, Mississauga, Ontario, Canada. Sponsors: IUGS Commission on Tectonics, the International Lithosphere Programme, and the Geological Survey of Canada. (H. C. Halls, Erindale Campus, Univ. of Toronto, Mississauga, Ontario L5L 1C6, Canada; tel.: 416-828-5363.)

June 8–12 Third International Conference on Toxic Dinoflagellates, St. Andrews, New Brunswick, Canada. (Alan W. White, Biological Station, Department of Fisheries and Oceans, St. Andrews, New Brunswick, Canada E0G2X0.)

June 9–15 IWRA Fifth World Congress, Brussels, Belgium. (Fifth World Congress on Water Resources, Brussels International Conference Centre, Parc des Expositions, Tentoonstellingspark, B-1020 Brussels, Belgium; tel.: 32-2-478-48-60; telex: 23-643.) (Aug. 30, 1983.)

June 9–16 52nd Session of the Permanent Committee of the International Federation of Surveyors (FIG), Katowice, Poland. (Komitet Organizacyjny PC 85, ul. Kosiutha 9, PL 40-835 Katowice, Poland, PO 108.)

June 12–14 19th Annual Canadian Meteorological and Oceanographic Society Congress and Annual General Meeting: Modelling in Meteorology and Oceanography, Montreal. (Organizers: Canadian Meteorological and Oceanographic Society, l'Université du Québec à Montréal. Jean-Guy Cantin or Richard Moffet, 100 Alexis-Nihon Blvd., 3rd Floor, Montreal, Quebec, Canada H4M 2N8; tel.: 514-333-3051.)

June 16–21 Third International Symposium on Analysis of Seismicity and Seismic Risk, Liblice, Czechoslovakia. (Z. Schenkova, Geophysical Institute, Bocni II, 14131 Prague 4, Czechoslovakia.)

June 18–21, 1985 Field Conference of the American Geomorphological Field Group, Arcata, Calif. (American Geomorphological Field Group Conference, Department of Geology and Geophysics, University of California, Berkeley, Berkeley, CA 94720; tel.: 415-642-5925.)

June 26–28 U.S. Symposium on Rock Mechanics, Rapid City, S. Dak. Sponsor, South Dakota School of Mines and Technology. (Eileen Ashworth, Chairman, 26th U.S. Symposium on Rock Mechanics, Dept. of Mining Engineering, South Dakota School of Mines and Technology, Rapid City, SD 57701-3995; tel.: 605-394-2344.) (Aug. 14, 1984.)

July 1–7 International Symposium on Karst Water Resources, Ankara and Antalya, Turkey. Sponsors: Karst Water Resources Research Center Project of Hacettepe Univ., U.N., Turkish State Hydraulic Works. (G. Ivan Johnson, Water Resources Consultant, Woodward-Clyde Consultants, 7600 East Orchard Rd., Harlequin Plaza North, Englewood, CO 80111, or Gultekin Gunay, Hydrogeological Engineering Dept., Hacettepe Univ., Engineering Faculty, Beytepe, Ankara, Turkey.)

July 15–17, 1985 Fourth International Hydrology Symposium: Multivariate Analysis of Hydrologic Processes, Fort Collins, Colo. Sponsors: AGU Hydrology Section, ASCE, IAHS, IWRA, IAHR. (H. W. Shen, Dept. of Civil Engineering, Hydrology and Water Resources Program, Foothills Campus, Colorado State Univ., Fort Collins, CO 80523.)

July 28–Aug. 2 8th Biennial International Estuarine Research Conference, Durham, N. H. Sponsor: Estuarine Research Foundation. (Björn Kjerfve, ERF Program Chairman, Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina, Columbia, SC 29208; tel.: 803-777-4529.)

July 29–Aug. 9 Tsunami 85: International Tsunami Symposium of the IUGG Tsunami Commission, Victoria, Canada. (Tsunami 85, P. O. Box 2207, Sidney, B.C., Canada V8L 3S8; tel.: 604-656-8343.)

Aug. 5–16 IAMAP/IAPSO Joint Scientific Assembly on the Large Scale Circulations of the Oceans and Atmosphere and their Interactions, Honolulu, Hawaii. Sponsors: IAMAP, IAPSO, AGU. (AGU, 2000 Florida Ave. N. W., Washington, DC 20009.)

Aug. 5–17 5th Scientific Assembly of IAGA, Prague, Czechoslovakia. (Michael Gadsden, Natural Philosophy Dept., Aberdeen Univ., Aberdeen AB9 2UE, Scotland.)

Aug. 5–17 Symposium on Magnetic Anomalies over the Margins of Continents and Plates, Prague, Czechoslovakia. Sponsor: IAGA. (William J. Hinze, Dept. of Geosciences, Purdue Univ., West Lafayette, IN 47907; tel.: 317-494-5982.) (Feb. 7, 1984.)

Aug. 11–16 Symposium on Groundwater Contamination and Reclamation, Tucson, Ariz. Sponsor: AWRA. (Nathan Buras, Dept. of Hydrology and Water Resources, Univ. of Arizona, Tucson, AZ 85721.) (Oct. 16, 1984.)

Aug. 11–16, 1985 Water Demand: Sharing a Limited Resource—The 21st Annual Conference and Symposium of the American Water Resources Association, Tucson, Ariz. (Yoram Gordon, Greenhorne & O'Mara, Inc. 9001 Edmonston Rd., Greenbelt, MD 20770; tel.: 301-982-2846.) (Oct. 9, 1984.)

Aug. 12–16 International Conference on the Occurrence, Properties, and Utilization of Natural Zeolites, Budapest, Hungary. Sponsor: Hungarian Academy of Sciences. (J. Engelhardt, Secretary, Zeolite '85, Central Research Institute for Chemistry, Hungarian Academy of Sciences, H-1525 Budapest, P. O. Box 17, Hungary.) (June 19, 1984.)

Aug. 13–16 Hydraulics and Hydrology in the Small Computer Age, Orlando, Fla. Sponsor: Hydraulics Division, American Society of Civil Engineers. (William R. Waldrop, TVA Water Systems Development Branch, PO Drawer E, Norris, TN 37828; tel.: 615-632-1460.)

Aug. 14–15 Symposium: Groundwater Contamination and Reclamation, Tucson, Ariz. Organizer: American Water Resources Association. (Nathan Buras, Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721; tel.: 602-621-5082 or Kenneth D. Schmidt, 4120 North 20th St., suite G, Phoenix, AZ 85016; tel.: 602-956-8711.)

Aug. 18–24 International Workshop on Hydrological Applications of Space Technology, Cocoa Beach, Fla. WMO, IAHS. (A. Ivan Johnson, 7474 Upham Court, Arvada, CO 80003.) (Oct. 9, 1984.)

Aug. 19–23 Sixth Gondwana Symposium, Columbus, Ohio. Sponsor: GSA. (D. Elliot, Ohio State Univ., Institute of Polar Studies, 103 Mendenhall, 125 South Oval Mall, Columbus, OH 43210.)

Aug. 19–24 Fourth Chilean Geological Congress, Antofagasta, Chile. Sponsor: Dept. of Geociencias, Universidad del Norte. (Organizing Committee, Fourth Chilean Geological Congress, Dept. of Geociencias, Universidad del Norte, Casilla (Box) 1280, Antofagasta, Chile; tel.: 222040–205.)

Aug. 19–30 23rd General Assembly of IASPEI, Tokyo, Japan. (Ryosuke Sato, Secretary-General of the 23rd General Assembly of IASPEI, c/o Inter Group Corp., Akasaka Yamakatsu Bldg., 8–5–32, Akasaka, Minato-ku, Tokyo 107, Japan; tel.: Tokyo (03) 479-5311.)

Aug. 25–28 Workshop on High Temperature Geothermal Drilling, Kailua-Kona, Hawaii. Sponsor: Geothermal Resources Council. (Grace Mata, Geothermal Resources Council, P. O. Box 1350, Davis, CA 95617–1350; tel.: 916-758-2360.)

Aug. 26–29 Third Circum-Pacific Terrane Conference, Sydney, Australia. Sponsor: Circum-Pacific Council for Energy and Mineral Resources. (Malcolm J. Lennox, Secretary, 3rd Circum-Pacific Terrane Conference, The Earth Resources Foundation, Edgeworth David Building, Univ. of Sydney, New South Wales, Australia 2006.)

Aug. 26–30 International Symposium on Geothermal Energy, Kailua-Kona, Hawaii. Sponsor: Geothermal Resources Council. (Geothermal Resources Council, P. O. Box 1350, Davis, CA 95617.) (tel.: 916-758-2360.)

Aug. 31–Sept. 1 Workshop on Fractures in Geothermal Reservoirs or Geothermal Exploration, Kailua-Kona, Hawaii. Sponsor: Geothermal Resources Council. (Grace Mata, Geothermal Resources Council, P. O. Box 1350, Davis, CA 95617–1350; tel.: 916-758-2360.)

September International Symposium on Variational Methods in Geosciences, Norman, Okla. Sponsors: AGU, Cooperative Institute for Mesoscale Meteorological Studies, Univ. of Oklahoma College of Geosciences. (Y. K. Sasaki, Univ. of Oklahoma, 815 Jenkins, Norman, OK 73019.)

September International Symposium on Deep Internal Processes and Continental Rifting, Chengdu, China. Sponsor: Chinese Lithosphere Committee. (Claude Froidevaux, Université Paris-Sud, Lab. Géophysique-Bât. 510, 91405 Orsay, France.)

Sept. 10–13 Envirosat '85, Washington, D.C. Organizer: NOAA. (Program Committee, 2nd Environsat Conference, NOAA/NESDIS, E/ER2, FB#4, Mail Stop D, Washington, DC 20233.)

Sept. 15–20 Sixth International Conference on Basement Tectonics, Santa Fe, N. Mex. (M. J. Aldrich, Mail Stop D462, Los Alamos National Laboratory, Los Alamos, NM 87545; tel.: 505-667-1495.)

Sept. 16–21 Symposia on Potassic Volcanism and Etna Volcano, Catania, Italy. Sponsor: IAVCEI. (G. Frazzetta and G. Lanzafame, Istituto Internazionale di Vulcanologia, V.le R. Margherita, 8, Catania, Italy.) (Dec. 27, 1983.)

Sept. 16–27 Advanced Study Institute on the Role of Air-Sea Exchange in Geochemical Cycling, Bombannes, Carcans, France. Organizer: NATO. (P. Buat-Ménard, Centre des Faibles Radioactivités, Domaine du CNRS, Avenue de la Terrasse, BP 1, 91190 Gif sur Yvette, France.)

Sept. 17–21 AIPG Annual Meeting, St. Paul, Minn. (Robert E. Prendergast, General Chairman, Geotechnical Engineering Corp., 1925 Oakcrest Ave., Roseville, MN 55113; tel.: 612-636-7744.)

Sept. 17–21 Second International Mine Water Congress, Granada, Spain. Sponsor: International Mine Water Association. (R. Fernandez Rubio, School of Mines, Technical Univ. of Madrid, Rios Rosas 21, Madrid 3, Spain.)

Sept. 19–23 International Symposium on Scientific Basis for Water Resources Management, Jerusalem. Sponsors: Israel Assoc. of Hydrology, IAHS. (SBWRM Israel '85, The Israel Assoc. of Hydrology, P. O. Box 6381, Jerusalem, Israel.) (July 31, 1984.)

Sept. 23–26 Biannual Conference of the Western Federation of Professional Land Surveyors (WFPLS), Portland, Oregon. (Grant E. Heppenstall, 17308 Booth Ave. SE, Bothell, WA 98012; tel.: 206-481-8532.)

Sept. 28–29 10th Annual Geomorphology Symposium on Hillslope Processes, Buffalo, N. Y. (Athol. D. Abrahams, Department of Geography, State Univ. of New York at Buffalo, Buffalo, NY 14260; tel.: 716-636-2289.)

Oct. 7–10 Workshop on the Statistical Aspects of Water Quality Monitoring, Burlington, Ontario, Canada. Organizer: National Water Research Institute of Environment Canada. (A. El-Shaarawi, Aquatic Physics and Systems Division, NWRI, Canada Centre for Inland Waters, PO Box 5050, Burlington, Ontario, Canada L7R 4A6; tel.: 416-637-4534; or R. E. Kwiatkowski, Water Quality Branch, IWD, Place Vincent Massey, Ottawa, Ontario, Canada K1A 0E7; tel.: 819-997-1991.)

Oct. 9–10 International Symposium on Management of Hazardous Chemical Waste Sites, Winston-Salem, N. C. Sponsors: AGU, U.S. National Committee of International Assoc. of Engineering Geology, Assoc. of Engineering Geologists. (Norman Tilford, Dept. of Geology, Texas A&M Univ., College Station, TX 77843–3115; tel.: 409-845-9882.)

Oct. 10–12 Conference on Heat and Detachment in Crustal Extension on Continents and Planets, Sedona, Ariz. Sponsor: Lunar and Planetary Institute, USGS, GSA. (Pam Jones, LPI Projects Office, Lunar and Planetary Institute, 3303 NASA Road 1, Houston, TX 77058; tel.: 713-486-2150.) (July 31, 1984.)

Oct. 14–18 Dissertation Symposium on Chemical Oceanography (DISCO), Honolulu, Hawaii. (Neil Andersen, Director, Marine Chemistry Program, National Science Foundation, Washington, DC 20550.)

Oct. 14–18 U.S.-China Bilateral Symposium on the Analysis of Extraordinary Flood Events, Nanjing, China. Sponsors: USGS, Bureau of Hydrology of the Ministry of Water Resources and Electric Power of the People's Republic of China. (Marshall E. Moss, Chief, Surface Water Branch, U.S. Geological Survey, 415 National Center, Reston, VA 22092; tel.: 703-860-6837.) (Sept. 11, 1984.)

October 15–17 International Symposium on Variational Methods in Geosciences, Norman, Okla. Sponsor: The Cooperative Institute for Mesometeorological Studies. (Symposium Arrangements Chairman, CIMMS, University of Oklahoma, 401 E. Boyd, Norman, OK 73019.)

Oct. 21–25 International Conference on Arid Lands: Today and Tomorrow, Tucson, Ariz. Sponsors: Arid Land Studies, University of Arizona, UNESCO, American Assoc. for the Advancement of Science. (C. P. Nabhan, Office of Arid Land Studies, Univ. of Arizona, Tucson, AZ 85721.)

Oct. 28–31 GSA 1985 Annual Meeting, Orlando, Fla. (Sue Beggs, Meetings Manager, GSA, P. O. Box 9140, Boulder, CO 80301; tel.: 303-447-2020.)

Oct. 28–31 AGU Chapman Conference on Magmatic Physics, Laurel, Md. (AGU Meetings, 2000 Florida Ave., N. W., Washington, DC 20009.)

Oct. 28–Nov. 1 International Conference on Coal Science, Sydney, Australia. Sponsor: International Energy Agency. (R. W. Hinde, Executive Secretary, CSIRO, Div. of Fossil Fuels, P. O. Box 136, North Ryde, NSW 2113, Australia.) (July 31, 1984.)

Nov. 4–8 Physics of Fracturing and Seismic Energy Release, Liblice, Czechoslovakia. (J. Kozák, Geophysical Institute, Bocni II, 14131 Prague 4, Czechoslovakia.)

Nov. 13–15 Meeting on Shuttle Environment and Operations II, Houston, Tex. Organizer: American Institute of Aeronautics and Astronautics. (Billy M. McCormac, Lockheed R&DD, D91-30/B202, 3251 Hanover St., Palo Alto, CA 94304; tel.: 415-424-2816.)

Dec. 9–13 AGU Fall Meeting, San Francisco, Calif. (Meetings, AGU, 2000 Florida Ave., N. W., Washington, DC 20009.)

1986

January Symposium on Geotechnical Applications of Remote Sensing and Remote Data Transmission, New Orleans, La. Sponsor: American Society for Testing and Materials. (A. Ivan Johnson, Woodward-Clyde Consultants, Harlequin Plaza-North, 7600 E. Orchard Road, Englewood, CO 80111; tel.: 303-425-5610.)

March 24–28 Pacific Congress on Marine Technology, PACON 86, Honolulu, Hawaii. Organizers: Marine Technology Society–Hawaii Section, Center for Engineering Research–University of Hawaii at Manoa. (N. Saxena, CNOC Chair in MC&G, Code 68 GX, Department of Oceanography, Naval Postgraduate School, Monterey, CA 93943; tel.: 408-646-3268.)

April 21–24 International Symposium on Environmental Geotechnology, Allentown, Pa. (H. Y. Fang, Symposium Chairman, Geotechnical Engineering Division, Dept. of Civil Engineering, Lehigh Univ. No. 13, Bethlehem, PA 18015.)

May 18–21 International Symposium on Flood Frequency and Risk Analyses, Baton Rouge, La. Co-sponsor: AGU. (Vijay Singh, Louisiana State Univ., Dept. of Civil Engineering, Baton Rouge, LA 70803–6405; tel.: 504-388-6697.)

May 19–23 AGU Spring Meeting, Baltimore, Md. (AGU, 2000 Florida Ave., N.W. Washington, DC 20009.)

June Conference on Study and Mitigation of Hazards, San Martin. Sponsor: Tsunami Society. (Hazards Conference, Box 60536, Las Vegas, NV 89160.) (Jan. 3, 1984.)

June 1–11 18th Congress of the International Federation of Surveyors, Toronto, Ontario, Canada. Hosts: Canadian Institute of Surveying. (FIG Congress '86, P. O. Box 186, Station Q, Toronto, Ontario M4T 1M2, Canada.)

June 3–6 Advancements in Aerodynamics, Fluid Mechanics, and Hydraulics, Minneapolis, Minn. Sponsors: Aerospace, Engineering Mechanics, and Hydraulic divisions of ASCE. (H. Stefan, St. Anthony Falls Hydraulic Laboratory, Department of Civil and Mineral Engineering, Mississippi River at Third Ave., S.E., Minneapolis, MN 55414; tel.: 612-373-2782.)

July 7–11 Geocongress '86: 21st Biennial Earth Science Congress, Johannesburg, South Africa. Sponsors: Geological Society of South Africa, IUGS. (Symposium Secretariat, S. 339, CSIR, PO Box 395, Pretoria, Republic of South Africa 0001.)

Aug. 4–8 International Symposium on Drainage Basin Sediment Delivery, Albuquerque, N. M. Sponsors: International Commission on Continental Erosion of the International Association of Hydrological Sciences, University of New Mexico. (R. F. Hadley, Secretary ICCE, c/o Department of Geography, Univ. of Denver, Denver, CO 80208–0183; tel.: 303-871-2672.)

Aug. 24–30 12th International Sedimentological Congress: Sediments Down-Under, Canberra, Australia. Sponsors: International Association of Sedimentologists, Geological Society of Australia, Geological Society of New Zealand, Bureau of Mineral Resources (geology and geophysics). (12th International Sedimentological Congress, ACTS, GPO Box 1929, Canberra ACT 2601, Australia; tel.: 062-49-8015; international: 6162 498015; telex: AA62260, UNHSE-ACTS.)

Sept. 7–12 Second International Conference on Paleoceanography, Woods Hole, Mass. (W. A. Berggren, Dept. of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA 02543.)

Sept. 7–12 ICS Symposium on Remote Sensing in Glaciology, Cambridge, England. (H. Richardson, International Glaciological Society, Lensfield Rd., Cambridge CB2 1ER, England.)

Dec. 8–12 AGU Fall Meeting, San Francisco, Calif. (AGU, 2000 Florida Ave., N. W., Washington, DC 20009.)

AAAS American Association for the Advancement of Science
AAPG American Association of Petroleum Geologists
ACS American Chemical Society
AIPG American Institute of Professional Geologists
AMS American Meteorological Society
ASCE American Society of Civil Engineers
AWRA American Water Resources Association
GSA Geological Society of America
IAG International Association of Geodesy
IAGA International Association of Geomagnetism and Aeronomy
IAHR International Association for Hydraulic Research
IAHS International Association of Hydrological Sciences
IAMAP International Association of Meteorology and Atmospheric Physics
IAPSO International Association for the Physical Sciences of the Ocean
IASPEI International Association of Seismology and Physics of the Earth's Interior
IAVCEI International Association of Volcanology and Chemistry of the Earth's Interior
ICSU International Council of Scientific Unions
IUGG International Union of Geodesy and Geophysics
IUGS International Union of Geological Sciences
IWRA International Water Resources Association
MSA Mineralogical Society of America
NWWA National Water Well Association
SEG Society of Exploration Geophysicists
SEPM Society of Economic Paleontologists and Mineralogists
URSI International Union of Radio Science
WMO World Meteorological Organization

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Aeronomy

0460 Tides, waves and winds NEUTRAL WIND SPECTRA AT THE AURORAL-ZONE MESOPAUSE: GEOMAGNETIC EFFECT? R. H. Johnson (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California, 90024) and J. G. Luhmann

[illegible]

J. Geophys. Res., A, Paper 4A8276.

Electromagnetics

0733 Remote Sensing
ACTIVE MICROWAVE MEASUREMENTS OF ARCTIC SEA ICE UNDER SUMMER CONDITIONS
R.G. Onstott (Remote Sensing Laboratory, University of Kansas Center for Research, Inc., Lawrence, Kansas 66045-2969) and S.P. Gogineni

[illegible]

J. Geophys. Res., C, Paper 4C1283.

6780 Scattering
THE SINGULARITY EXPANSION METHOD AND MULTIPLE SCATTERING
D. J. Riley (Sandia National Laboratories, Division 1231, Albuquerque, New Mexico, 87185), N. A. Davis and I. M. Besieris

[illegible]

Rad. Sci., Paper 4S1210.

Geochemistry

1410 Geochemistry (Chemistry of the Atmosphere)
BEHAVIOR OF TRACE NO_x SPECIES IN THE NIGHTTIME URBAN ATMOSPHERE
J. P. Killus (Systems Applications, Inc., 101 Lucas Valley Road, San Rafael, California, 94903), G. Z. Whitten.

[illegible]

J. Geophys. Res., D, Paper 4D1195.

Hydrology

3125 Glaciology
A NUMERICAL MODEL OF INTERACTIONS BETWEEN A MARINE ICE SHEET AND THE SOLID EARTH: APPLICATION TO A WEST ANTARCTIC ICE STREAM
Craig S. Lingle (Geophysical Institute for Research in Environmental Sciences, University of Colorado, Boulder, Colorado 80309), James A. Clark.

[illegible]

J. Geophys. Res., C, Paper 4C1221.

3199 Miscellaneous (Geomorphology)
THE DEVELOPMENT OF TRIBUTARIES OF DIFFERENT SIZES ALONG WINDING STREAMS AND VALLEYS
A. D. Abrahams (Geography Department, State University of New York at Buffalo, Buffalo, New York, 14260)

[illegible]

Water Resour. Res., Paper 4W1233.

0490 Instruments and techniques
A PRELIMINARY SPECTROSCOPIC ASSESSMENT OF THE SPACELAB 1/SHUTTLE OPTICAL ENVIRONMENT
R. R. Torr (Center for Atmospheric and Space Sciences, Utah State University, Logan, Utah 84322), and D. G. Torr

[illegible]

Meteorology

[illegible]

National Laboratory, Argonne, IL 604391, D. R. Cook, R. L. Hart, and R. M. Speer (U. S. Environmental Protection Agency)

Eddy-correlation measurements of particulate sulfur fluxes at the 1981 and 1982 Dry Deposition Intercomparison Experiments indicate a strong diurnal variation in deposition velocity (downward flux divided by concentration, at a height near 6 m). Most of the run-to-run variability for data collection periods of 30 min seems to be due to unwanted sensor noise. Systematic changes of fluxes with height due to possible advection from strong point sources of sulfur can occur but should be quite small. A parameterization for deposition velocity is derived in terms of friction velocity u_* and the Obukhov stability length scale L. When the parameterization is applied in conjunction with nearly continuous measurements of mean micrometeorological variables such as wind speed and temperature difference, the resulting long-term mean deposition velocity found is 0.22 ±0.06 cm s^{-1} with a variation greater than ±50% from day to day, depending on local atmospheric conditions. Peak deposition velocities greater than 0.5 cm s^{-1} occur on windy afternoons. Such values are considerably greater than suggested from wind-tunnel and theoretical investigations, but are similar to past results obtained by use of the same techniques over lush vegetation. Boundary-layer convective motions that increase wind gustiness near the surface seem to increase particle deposition velocities considerably. Relatively small deposition velocities are found in neutral and stable atmospheric conditions or over surfaces that lack complex fine structures. (Dry deposition, particulate sulfur, surface fluxes).

J. Geophys. Res., D, Paper 4D1250.

3770 Particles and aerosols
DELAYED PRODUCTION OF SULFURIC ACID CONDENSATION NUCLEI IN THE POLAR STRATOSPHERE FROM EL CHICHON VOLCANIC VAPORS.
D. J. Hofmann (Department of Physics and Astronomy, University of Wyoming, Laramie, Wyoming 82071), J. M. Rosen and W. Gringel

Using balloonborne condensation nuclei counters at Laramie, Wyoming (41°N), a large increase in what appear to be small sulfuric acid droplets above 29 km altitude was detected on January 28, 1983. Simultaneous reductions in electrical conductivity in the layer supported the aerosol observations. The air sample associated with this event appears to have originated in the north polar region where a stratospheric warming episode was taking place. It is believed that the substantial warming in the region may have been sufficient to vaporize resident sulfuric acid aerosol which were mainly derived from the El Chichon volcanic eruption 10 months earlier and transported to the polar region during winter. It is further believed that subsequent rapid cooling of the vapor during transport to the latitude of Laramie resulted in the nucleation of the small droplets, forming an extensive sulfuric acid fog above 29 km. The upper boundary of the cloud was not determined but extended to at least the maximum altitude attained (32.5 km). Longitudinal spreading appears to have been rapid and remnants of the fog were detected as far south as 32°N in May and persisted throughout the year at Laramie. A similar phenomenon is believed to occur in the Antarctic stratosphere as revealed in a measurement there in the southern hemisphere spring (October, 1983). (Volcanic aerosols, stratospheric aerosols).

J. Geophys. Res., D, Paper 4D1280.

3770 Particles and Aerosols
AN ESTIMATE OF THE EFFECT OF EL CHICHON AEROSOL ON SBUV OZONE PROFILING FOR SUMMER 1982
J. L. Mergenthaler (Meteorology Department, Florida State University, Tallahassee, Florida 32306)

A case study of errors introduced by the presence of high stratospheric aerosol concentrations into ozone mixing ratio profiles inferred from simulated measurements of solar backscattered ultraviolet radiation has been conducted for the average stratospheric conditions in the northern tropics during the summer of 1982. The spectral radiance reflected from the atmosphere was computed for seven wavelengths used in ozone recovery by the SBUV instrument. The simulated measurements, based on the average July 1979 ozone profile for the northern tropics and published aerosol data, were inverted for ozone mixing ratio profile by a procedure which does not take aerosol effects into account. Comparison is made between the "actual" and solution ozone mixing ratio profiles. It is found that the presence of El Chichon aerosol could cause an error in the neighborhood of -25% in the inferred cumulative ozone above 100 mb. (Aerosols, ozone, remote sensing).

J. Geophys. Res., D, Paper 4D1247.

3770 Particles and Aerosols
AN EVALUATION OF OPTICAL PARTICLE COUNTER MEASUREMENTS OF THE DRY DEPOSITION OF ATMOSPHERIC AEROSOL PARTICLES
P.C. Katen (Department of Atmospheric Sciences, Oregon State University, Corvallis, Oregon 97331) and J.M. Hubbe (Battelle Pacific Northwest Labs, P.O. Box 999, Richland, Washington 99352)

Eddy correlation flux measurements of total atmospheric aerosol particulates were collected over a grass surface at Champaign, Illinois in June, 1982. PMS ASAS-300A and Royco 225 optical particle counters were used as sensors to measure fluxes in 4 size ranges from 0.15 to 2.5 µm. The fluxes were quite variable, both in time and between sensors. The sensor signals are also quite noisy but we demonstrate that, within certain limitations, the sensor systems are [illegible]

Oceanography

[illegible]

The vertical and horizontal distributions of Ge concentrations in seawater are thus identical to those of silica (Ge/Si ~ 0.7 X 10^{-6}), and reflect uptake into and dissolution from the frustules of siliceous organisms. Germanium enters the ocean via dissolution of continental and sea-floor silicates. The naturally weathered flux from continents to oceans carries a dissolved Ge/Si atom ratio in rivers of about 0.7 X [illegible]

[illegible]

J. Geophys. Res., C, Paper 4C1273.

4720
EFFECT OF THE EMPEROR SEAMOUNTS ON THE MESOSCALE THERMOHALINE STRUCTURE DURING THE SUMMER OF 1982
G.I. Roden (School of Oceanography, University of Washington Seattle, 98195) and B.A.Taft (Pacific Marine Environmental laboratory NOAA, Seattle, 98115)

The influence of the Emperor Seamount Chain upon the mesoscale thermohaline structure and upon geopotential heights are investigated on the basis of a field experiment in the summer of 1982. The Kuroshio Extension approached the seamounts on a southeastward course and was deflected by Kinmei Seamount in an anticyclonic loop. The deflection led to a weakening of this current over the seamount and to reintensification on the downstream side. Uplift of isopycnals above seamount peaks and vertical displacements along seamount flanks were generally observed, but the details varied considerably from one seamount to the next. A Taylor column like feature occured over Suiko Seamount. A very large asymmetric density dome was found 40 km west of Jingu Seamount, atop which a density front was located. In the main gap between the northern and southern seamounts prominent wedgelike intrusions of subarctic and Kuroshio type water were observed in the upper few hundred meters. The isopycnals in the main gap sloped sharply toward the south, indicating a strong eastward baroclinic flow component. Geopotential heights over the Emperor Seamounts indicate strong local perturbations superposed upon larger scale slopes. In terms of geometric distance, perturbation heights reached 0.32 m and maximum sea surface slopes were $5 \cdot 10^{-6}$. These slopes produce baroclinic currents up to 0.5 m s^{-1} around the seamounts. (Emperor Seamounts, Mesoscale thermohaline structure)

J. Geophys. Res., C, Paper 4C1276.

4765
A COMPARISON OF IN SITU AND AIRBORNE RADAR OBSERVATIONS OF OCEAN WAVE DIRECTIONALITY
F. C. Jackson (NASA Goddard Space Flight Center, Code 671, Greenbelt, MD 20771), W. T. Walton, and C. Y. Peng

The directional spectrum of a fully arisen ~ 3 m sea as measured by an experimental airborne radar, the NASA K_u-band Radar Ocean Wave Spectrometer (ROWS), is compared to reference pitch-roll buoy data and to the classical SWOP (Stereo Wave Observation Project) spectrum for fully developed conditions. The ROWS spectrum, inferred indirectly from backscattered power measurements at 5 km altitude is shown to be in excellent agreement with the buoy spectrum. Specifically, excellent agreement is found between the two nondirectional height spectra and mean wave directions and directional spreads as functions of frequency. This agreement is found despite certain discrepancies between the radar and buoy angular harmonics which are believed to be due to buoy instrumental effects. A comparison of the ROWS and SWOP spectra shows the two spectra to be very similar in detailed shape as well as in terms of the gross spreading characteristics. Both spectra are seen to exhibit bimodal structures which accord with the Phillips' resonance mechanism. This observation is thus seen to support Phillips' contention that the SWOP modes were indeed resonance modes, not statistical artifacts (Microwave radar wave spectra).

J. Geophys. Res., C, Paper 4C1273.

4765 Surface Waves
OBSERVATIONS OF SURF BEAT
R. T. Guza (Shore Processes Laboratory, Scripps Institution of Oceanography, La Jolla, CA 92093), and Edward B. Thornton

The magnitudes of cross-shore velocity and elevation oscillations at surf beat frequencies observed on three ocean beaches are found to be significantly correlated with the significant height of incident wind waves. Measured surf beat run-up spectra are coupled with numerical integrations of the long wave equations to predict the energy spectrum at offshore sensors, and the coherence and phase between offshore sensors and run-up meter. As in previous studies, peaks and valleys in the surf beat energy spectra, and jumps in the relative phase between sensors, are consistent with simple standing wave (either leaky or high mode edge wave) models and are the result of standing wave nodes and antinodes. (surf beat, infragravity waves)

J. Geophys. Res., C, Paper 4C1271.

Particles and Fields— Interplanetary Space

5310 Cosmic Rays
LARGE SCALE SOLAR MODULATION OF > 500 MEV/N GALACTIC COSMIC RAYS SEEN FROM 1-30 AU
W. Fillius (Center for Astrophysics and Space Sciences, University of California, San Diego, La Jolla, California 92093), I. Axford

Using measurements of > 500 MeV/N cosmic rays obtained by Cerenkov counters on Pioneer 10 and 11, and neutron monitor data from earth, we can observe the spatial and temporal development of cosmic ray modulation during the last solar maximum. The large-scale features of modulation and recovery are similar at these three sites; and, thus, appear rotationally symmetric near the ecliptic plane. Outward-propagating features characterize the radial independence. The decline of the old cosmic ray cycle is marked by steplike decreases that propagate outward at nearly the solar wind velocity, as pointed out by other investigators. During the start of the new cosmic ray cycle, recovery occurs first in the inner heliosphere and, after a lag comparable with that of the declining phase, appears later farther out. However, the direction of diffusive propagation is still inward, because the gradient remains positive. Forbush decreases are common at all three sites, and are evidently of great importance in understanding modulation. The largest decrease occurred during a short series of events in summer, 1982, and had half the amplitude of the eleven year cycle. (cosmic ray modulation, solar cycle, Pioneer 10 & 11, outer heliosphere)

J. Geophys. Res., A, Paper 4A8305.

5320 Cosmic Ray Effects in Meteorites
CARBON-14 AGES OF ANTARCTIC METEORITES WITH ACCELERATOR AND SMALL VOLUME COUNTER TECHNIQUES
A. J. T. Jull (Physics Department, University of Arizona, Tucson, Arizona 85721), D. J. Donahue, T. H. Zabel, and E. L. Fireman

Carbon-14 terrestrial ages of six Antarctic meteorites have been measured by accelerator mass spectrometry. These six and three additional Antarctic meteorites were also measured by small counters. Results are in general agreement, with some differences that are related to the calibration samples used. Yamato 75102 was found to be the youngest meteorite yet measured from the Antarctic collections, 3x10^3 yrs. The ages for the Yamato meteorites studied are younger than those from sites in the Allan Hills region. Accelerator data on Allan Hills (ALHA) samples, 77232 and 80101, show limit ages >48x10^3 yrs. Counter measurements on ALHA 77208, 77269, and 79025 give limit ages >38x10^3, >34x10^3, and >38x10^3 yrs, respectively. Accelerator measurements on MBRA 76001, a sample previously measured by counting, gives a finite age of 39±2x10^3 yrs. The younger ages of meteorites of the Yamato region are suggested to be the result of the larger recovery area and the more "porous" barrier at the Yamato Mountains. (Meteorites, terrestrial ages, Carbon-14)

J. Geophys. Res., B, Paper 4B5910.

5340 Shock waves
THE EVOLUTION OF INTERPLANETARY SHOCKS
H. V. Cane (Laboratory for High Energy Astrophysics, NASA/Goddard Space Flight Center, Greenbelt, Maryland, 20771)

Unambiguous identification of the solar events associated with 48 interplanetary (IP) shocks has been facilitated by the observation of radio emission generated by the shocks. IP Type II radio emission is dependent on shock velocity with faster shocks producing more intense emission. All but two of the solar events associated with IP Type II radio emission included long duration soft X-ray events (LDE's). It is shown that all intense LDE's are associated with IP shocks. A weak correlation between the integral flux of soft X-rays and the average velocity of the associated shock is suggested. However, for two events all the usual flare signatures were absent and the events are associated with the disappearance of solar filaments. It is shown that the shocks propagate isotropically over about 50 degrees from the source site. Beyond 50 degrees the shocks weaken; particularly on their eastern flanks. As a consequence, shocks originating on the west limb cannot reach the earth. (Interplanetary shocks, solar events).

J. Geophys. Res., A, Paper 4A8120.

5360
ELECTRON PLASMA WAVES UPSTREAM OF THE EARTH'S BOW SHOCK
C. Lacombe, A. Mangeney, C.C. Harvey (DESPA, Observatoire de Paris-Meudon, 92195 Meudon, France), and J.D. Scudder

Electrostatic waves are observed around the plasma frequency f_{pe} in the electron foreshock together with electrons backstreaming from the bow shock. Using data from the sounder aboard ISEE 1, we show that this noise, previously understood as narrow band Langmuir waves more or less widened by Doppler shift or nonlinear effects, is in fact composed of two distinct parts: i) a narrow band noise, emitted just above f_{pe}, and observed at the upstream boundary of the electron foreshock. This component has been interpreted as Langmuir waves excited by a beam-plasma instability. We suggest that it is of sufficiently large amplitude and monochromatic enough to trap resonant electrons. ii) a broad band noise, more impulsive than the narrow band noise, observed well above and/or well below f_{pe}, deeper in the electron foreshock. The broad band noise has an envelope spectrum with a typical bi-exponential shape; its peak frequency is not exactly equal to f_{pe} and depends on the Debye length. This peak frequency also depends on the velocity for which the electron distribution has maximum skew. An experimental determination of the dispersion relation of the broad band noise shows that this noise, as well as the narrow band noise, may be due to the instability of a hot beam in a plasma. (Electric fields, Electron measurements, Plasma instability).

J. Geophys. Res., A, Paper 4A8128.

5380 Solar wind plasma (Long period Alfven waves)
EVIDENCE FOR LONG PERIOD ALFVEN WAVES IN THE INNER SOLAR SYSTEM
R. Bruno (CNR/Istituto di Fisica dello Spazio Interplanetario, C.P. 27, 00044 Frascati, Italy), B. Bavassano, U. Villante

Magnetic field and plasma data of Helios 1 and 2 between 0.3 and 1 AU have been used to investigate the Alfvenic character of the solar wind fluctuations with period above 1 hour. Clear evidence for the existence of very long period Alfven waves, up to 15 hours (in the spacecraft frame) close to the sun, has been obtained. The observations at different heliocentric distances suggest that the longest wavelengths are removed from the Alfvenic regime going away from the sun.

J. Geophys. Res., A, Paper 4A8110.

Particles and Fields— Ionosphere

5530 High-latitude ionospheric currents
ON THE ANTICORRELATION OF THE ELECTRIC FIELD AND PEAK ELECTRON ENERGY WITHIN AN AURORAL ARC
A. J. Mallinckrodt (Joint Sciences Department, Claremont Colleges, Claremont, California 91711) and C. W. Carlson

Data from the second flight of the Aries Porcupine sounding rocket campaign are presented and analyzed. The data reveal auroral electrons with spectral peaks at energies up to 4 keV and the dc electric field shows a remarkable degree of anticorrelation with the peak electron energy. Electron precipitation data are used as input to a numerical simulation of the auroral ionosphere to calculate ion production rates. From these and the recombination rates, the equilibrium electron density is calculated, properly accounting for the effective drift velocity of ionization from its point of production. Using the classical formulas, the Pedersen and Hall conductivities in the neutral frame are then calculated. Finally, various combinations of the arc motion velocity and neutral wind velocity are used to compute the resulting electric field component normal to the arc with the observations. The results imply that the ionization produced by the auroral electrons does not move with the E x B drift velocity, perhaps the result of a larger collisional coupling to neutrals than expected. A relationship is obtained between the components of the neutral wind velocity parallel and perpendicular to the arc. The observed anticorrelation is attributed to the blockage of field-aligned current and the resulting polarization of the ionosphere as well as the relatively linear relationship between peak electron energy and height integrated conductivity for peak energies below a few keV.

J. Geophys. Res., A, Paper 4A1010.

5530 High-latitude Ionospheric currents
OBSERVATIONS OF ELECTRON BEAMS IN THE LOW LATITUDE BOUNDARY LAYER
K. W. Ogilvie (NASA/GSFC, Lab. for Extraterrestrial Physics, Greenbelt, MD 20771), R. J. Fitzenreiter and J. D. Scudder

Observations made with the electron spectrometer on the ISEE-1 spacecraft have been used to perform a study of the electron distribution function in the low latitude boundary layer of the magnetosphere (LLBL) in the sunward direction. The LLBL is defined to be a layer of plasma of thickness ≈ 1Re inside and adjacent to the magnetopause, having a density intermediate between that of the magnetosheath and the magnetosphere. The study included 43 examples of especially well-defined layers having densities, n_{BL}, such that $(n_{magnetosphere}/n_{BL}) \geq 0.1$ and $(n_{BL}/n_{magnetosheath}) \geq 0.1$, although both ratios were occasionally as low as 0.01. Recent observations (e.g., Burch et al., 1983) have indicated that electrons with energies in the 100 eV range are frequently exchanged between the ionosphere and the magnetosphere, traveling along the magnetic field lines near to the cusps and giving rise to Birkeland currents. Using 3-D model-independent distribution functions of electrons observed in the boundary layer we have identified beams of field aligned electrons with energy maximum typically 100 eV, distributed over the energy range 50 eV to 200 eV, streaming in either one or both directions. The phase densities in the LLBL and at lower altitudes are similar, and assuming no further acceleration to have occurred, we identify the beams we observe in the LLBL with those observed at lower altitudes. They form an important component of the plasma electrons in the LLBL, which otherwise resembles a mixture of magnetosheath-like and magnetospheric electrons. The bi-directional streaming also suggests that the field lines threading the LLBL are often closed. The reduced distribution functions of electrons in the LLBL do not show positive slopes in the velocity range of the beams, suggesting that the plasma is stable to the growth of longitudinal electrostatic waves. (Boundary layer, electron beams, ionosphere).

J. Geophys. Res., A, Paper 4A1140.

5530 High-latitude ionospheric currents
A NUMERICAL SIMULATION OF AURORAL IONOSPHERIC ELECTRODYNAMICS A. J. Mallinckrodt (Joint Sciences Department, Claremont Colleges, Claremont, California 91711)

A computer simulation of auroral ionospheric electrodynamics in the altitude range 80 to 250 km has been developed. The routine will either simulate typical electron precipitation profiles or accept observed data. Using a model background ionosphere, ion production rates are calculated from which equilibrium electron densities and the Hall and Pedersen conductivities may be determined. With the specification of suitable boundary conditions, the entire three-dimensional current system and electric field may be calculated within the simulation region. The results of the application of the routine to a typical inverted-V precipitation profile are demonstrated. In a companion paper, the routine is used to explore the observed anticorrelation between electric field magnitude and peak energy in the precipitating electron spectrum of an auroral arc.

J. Geophys. Res., A, Paper 4A1009.

5530 Low-latitude Ionospheric Currents
MODELLING THE EQUATORIAL ELECTROJET
Robert J. Stening (School of Physics, The University of New South Wales, Kensington 2033, Australia),

The equivalent circuit method has been modified to give greater accuracy and greater detail near the equator in order to model the equatorial electrojet. Electron collision frequencies used in the conductivity model are consistent with laboratory measurements. Variations with longitude are allowed and the electrojet in the model is driven by suitable emf's generated by a global thermotidal wind system. The height of maximum current density in the Indian electrojet provided by the model at 104 km is consistent with some observations. The model gives the same height in Peru when an electron density profile typical of that region is used. The form of the electron density profile is shown to have a considerable effect on the current profile. The calculated variation with latitude of height integrated current density gives good agreement. The two-layer equivalent circuit model is more successful than the single-layer model in modelling the latitude profile of the jet but the observed depression in AH near 4° dip latitude requires much larger changes in currents with latitude than either model can provide. The theory that currents are limited by the two stream instability does not agree with measured altitude profiles of the jet. Before latitude variations of AH and AZ on the ground can satisfactorily be explained, greater understanding of the contribution of conductivity anomalies to internal components will be required, but, with suitable assumptions, a good fit with observed results is obtained. The effects produced by a simple local F region wind system are also investigated. A discrepancy with the observed relationship between integrated current densities and AH still awaits explanation. (Equatorial electrojet, geomagnetic daily variations.)

J. Geophys. Res., A, Paper 4A1212.

5560 (Particle precipitation)
LIGHTNING-INDUCED ELECTRON PRECIPITATION FROM THE MAGNETOSPHERE
H. C. Chang (Space, Telecommunications and Radioscience Lab, Stanford University, Stanford, California 94305), U. S. Inan

Precipitation of radiation belt particles induced by whistlers that are generated by atmospheric lightning discharges and propagate over L-shells of 2-4.5 is considered. Using a test particle model of the whistler-particle interaction, the energy spectra and temporal profile of whistler-induced fluxes as a function of L-shell are quantitatively determined for a representative plasmaspheric cold plasma distribution. Results indicate that for higher energy electron precipitation (E > 40 keV) there exists an inner magnetospheric region (2 < L < 3) where the level of whistler-induced precipitation can be expected to be comparatively high. Implications of this finding in terms of observational results are discussed. (Lightning, whistlers, particle precipitation)

J. Geophys. Res., A, Paper 4A8265.

5560 Particle precipitation
PIONEER-VENUS SUPRATHERMAL ELECTRON FLUX MEASUREMENTS IN THE VENUS UMBRA
William C. Knudsen (Knudsen Geophysical Research, 18475 Twin Creeks Rd, Monte Sereno, CA 95030) and Kent L. Miller

Statistical properties of the two Maxwellian electron densities and temperatures characterizing the differential suprathermal electron fluxes measured by the Pioneer-Venus Lockheed-IPW retarding potential analyzer in the Venus umbra between approximately 1000 and 2000 km altitude and nightward of 130° solar zenith angle are reported. We find that the median density n_1 and temperature T_1 of the principal Maxwellian component are 3 cm^{-3} and 14 eV, respectively, and do not exhibit an altitude or solar zenith angle dependence within the umbra region studied. Two-thirds of the measured values of n_1 and T_1 typically fall within plus or minus a factor of two of the median values. The second suprathermal component density n_2 is less well defined but has a median value of 0.06 cm^{-3} and similarly exhibits no clear altitude or solar zenith angle dependence. Two-thirds of the n_2 values fall within plus or minus a factor of two of the median value. The temperature T_2 of the second component is assumed constant and equal to 200 eV. The median integral flux measured in this study between 15 and 45 eV energy is consistent with that reported earlier for the Venus nightside ionosphere by Spenner et al. (1981) at altitudes below 1000 km. The integral flux measured by the Pioneer-Venus retarding potential analyzer appears to be larger than the Venera measured median flux by a factor of approximately two in the energy range of the Pioneer-Venus retarding potential analyzer.

J. Geophys. Res., A, Paper 4A8230.

5580 Wave Propagation
IONOSPHERIC SCINTILLATION MEASUREMENTS AT 1.5 GHZ IN MID-LATITUDE REGION
Y. Karasawa (Research and Development Laboratories, KDD, 2-1-23, Nakameguro, Meguro-ku, Tokyo 153, Japan), K. Yasukawa and H. Yamada

The results of 1.5 GHz scintillation measurements at Yamaguchi, Japan are described. Measurements were carried out by receiving a 1.5 GHz beacon signal from the MARISAT satellite over the Indian Ocean with an elevation angle of 17.3°. In 13 months of measurements, very severe scintillation with peak-to-peak fluctuations exceeding 30 dB was observed in the equinoctial month, and a number of spike-type scintillations were also observed, particularly at night. Scintillation characteristics, such as diurnal and seasonal variations, amplitude distribution, spectrum, and depolarization are discussed. (Ionospheric scintillation, Mid-latitude scintillation, L-band measurements)

Rad. Sci., Paper 4S1219.

Particles and Fields— Magnetosphere

5733 Magnetic storms
SUPRATHERMAL O^+ AND H^+ ION BEHAVIOR DURING THE 22 MARCH 1979 (CDAW-6) SUBSTORMS
F.M. Ipavich (Dept. of Physics and Astronomy, University of Maryland, College Park, MD 20742), A.B. Galvin, H. Scholer, G. Gloeckler, D. Hovestadt and B. Klecker

We present measurements of energetic (~130 keV) O^+ ions in the earth's magnetosphere during the two CDAW-6 substorms on 22 March 1979. The behavior of thermal and suprathermal H^+ (10 - 130 keV) and suprathermal He^{++} (30 - 130 keV/e) ions is also discussed. The observations were made with the UMD/MPE ULECA sensor on ISEE-1 at geocentric distances ~7 to 16 R_E in the earth's magnetotail. Approximately 15 minutes before the 1054 UT onset of the first substorm energetic O^+ ions are observed streaming tailward. H^+ and He^{++} ions at all energies were generally streaming tailward from ~1059-1115 UT, consistent with the presence of a near-earth neutral line during this interval. From 1117-1124 UT the H^+ and He^{++} ions were observed flowing earthward, suggesting that at ~1117 UT the neutral line retreated tailward. A brief interval in the southern tail lobe, from ~1124-1126 UT, was highlighted by an intense O^+ beam streaming tailward; the O^+/H^+ ratio at 130 keV was 7±2. This suggests that high energy O^+ ions may be accelerated directly out of the ionosphere. The recovery phase of the first substorm began a few minutes later and was characterized by large intensities of nearly isotropic suprathermal ions. The O^+/H^+ differential intensity ratio at 130 keV was quite large (~1) during the recovery phase of both substorms. (Substorms, particle acceleration, particle composition).

J. Geophys. Res., A, Paper 4A5078.

5736 Magnetic tail
MAGNETOTAIL PLASMA OBSERVATIONS DURING THE 10:54 UT SUBSTORM ON 22 MARCH 1979 (CDAW 6)
G. Paschmann (Max-Planck-Institut für Physik und Astrophysik, Institut für extraterrestrische Physik, 8046 Garching b. München, W-Germany), N. Sckopke, E.W. Hones, Jr.

The paper reports ISEE-1 and -2 plasma observations in the plasma sheet near 13 Re radial distance for the 10:54 substorm on 22 March 1979. Noteworthy features are plasma sheet thinning and the brief appearance of rapid tailward flows after substorm onset, strong earthward flows (superimposed on dawnward convection) at the beginning of plasma sheet expansion and a quieting of all plasma properties at substorm recovery. Much of the time, however, plasma flows are small and switch directions. In particular, no strong flows are observed during neutral sheet crossings. Two-dimensional velocity distribution function show a complex behavior, with several plasma components often coexisting and at times streaming in opposite directions. The interpretation of the observations in terms of the formation of a neutral line earthward of and close to ISEE at substorm onset is tempting, but three-dimensional spatial effects as well as rapid temporal changes have to be invoked to obtain consistency.

J. Geophys. Res., A, Paper 4A8195.

5739 Magnetopause
MAGNETOPAUSE MERGING SITE ASYMMETRIES
R. U. Crooker (Department of Atmospheric Sciences, University of California, Los Angeles, CA 90024), J. G. Luhmann, J. R. Spreiter and S. S. Stahara

Regions where a draped model magnetosheath magnetic field is nearly antiparallel to a model geomagnetic field are shown to be asymmetric for an interplanetary magnetic field (IMF) at the garden hose angle, as suggested by Maelis. When the IMF has a southward component, the asymmetry favors the dawn region for both IMF polarities. The dusk region is favored when the IMF has a northward component. If the regions of antiparallel fields are assumed to be sites of maximum magnetic merging, then this asymmetry is consistent with observed seasonal variations of geomagnetic activity and with dawn-displaced magnetospheric phenomena. In the alternate geometry of a merging line passing through the subsolar region, the asymmetry is predominantly north-south rather than dawn-dusk. The subsolar merging-line geometry is consistent with the seasonal variations but not with the dawn-displaced phenomena. (Merging, daysides, antiparallel).

J. Geophys. Res., A, Paper 4A8238.

5770 Short-period (less than 1 day) variations of magnetic field
CHARGED PARTICLE BEHAVIOR IN LOW FREQUENCY GEOMAGNETIC PULSATIONS: 4. COMPRESSIONAL WAVES
H.O. Kivelson (Dept of Earth & Space Sciences, and Inst. of Geophysics & Planetary Physics, Univ of California, Los Angeles, CA 90024), and D.J. Southwood

In this fourth paper of a series concerning charged particle behavior in ultra low frequency (ULF) waves in the terrestrial magnetosphere, we examine the particle flux response expected in waves with a strong compressional magnetic component. Two effects, which we label betatron and mirror, dominate the behavior expected for nonresonant particles with the mirror effect expected in most circumstances. Resonant behavior is a strong function of signal symmetry, such as discussed in earlier papers. We conclude by examining recently published observations of particle flux oscillations associated with compressional signals.

J. Geophys. Res., A, Paper 4A1269.

5799 General (In plasma torus)
REVISED ION TEMPERATURES FOR VOYAGER PLASMA MEASUREMENTS IN THE IO PLASMA TORUS
Fran Bagenal (Imperial College of Science and Technology, Prince Consort Road, London SW7 2BZ, England), Ralph L. McNutt, Jr., John W. Belcher, Herbert S. Bridge and James D. Sullivan.

The purpose of this paper is to report that an error was made in computing the ion temperatures for some of the positive ion data obtained by the Plasma Science Experiment on the Voyager spacecraft. The error caused some of the ion temperatures to be quoted at half the correct value; previously reported results affected in this way are the ion temperatures in the inner magnetosphere of Jupiter as quoted in the following articles: 'Spatial Distribution of Plasma in the Io Torus', F. Bagenal, J. D. Sullivan and G. L. Siscoe, Geophys. Res. Lett., 7, 41, 1980 and 'Direct Plasma Measurements in the Io Torus and Inner Magnetosphere of Jupiter', F. Bagenal and J. D. Sullivan, J. Geophys. Res. 86, 8447, 1981. In addition a single ion temperature calculated from Voyager 1 data obtained in the magnetosphere of Saturn was affected by this error. This result was reported in the article: 'Plasma Observations Near Saturn: Initial Results from Voyager 1', H. S. Bridge et al., Science 212, 217, 1981. All other ion temperatures derived from the PLS data obtained near Jupiter and Saturn are correct as originally reported. (Io plasma torus, plasma temperature).

J. Geophys. Res., A, Paper 4A8310.

Planetology

6530 Gross Properties of Planets
VENUS TOPOGRAPHY: A HARMONIC ANALYSIS
Bruce G. Bills (Lunar & Planetary Institute, Houston, TX 77058) Michael Kobrick

A model of Venusian global topography has been obtained by fitting an eighteenth degree harmonic series to Pioneer Venus Orbiter radar altimeter data. The mean radius is (6051.45 ± 0.04) km. The corresponding mean density is (5244.8 ± 0.5) kg m^{-3}. The center of figure is displaced from the center of mass by (0.319 ± 0.088) km towards (6.6 ± 10.1)° N, (148.8 ± 7.7)° E. The figure of Venus is distinctly triaxial, but the orientation and amplitudes of the principal topographic axes correlate rather poorly with the gravitational principal axes. However, the higher degree harmonics of topography and gravity are significantly correlated. The topographic variance spectrum of Venus is very similar in form to those of the Moon, Mars and especially Earth. We suggest that this spectral similarity simply reflects a statistical balance between constructional and degradational geomorphic processes. Venus and Earth are particularly similar (and differ from the Moon and Mars) in that the larger bodies both exhibit a significant low degree deficit (relative to the extrapolated trend of the higher harmonics).

J. Geophys. Res., B, Paper 4B1159.

6560 Meteoritics
THE CASE FOR A MELT MATRIX IN PLAGIOCLASE-POIK MESOSIDERITES
Roger H. Hewins (Department of Geological Sciences, Rutgers University, New Brunswick, New Jersey, 08903).

The plagioclase-POIK mesosiderites, Bondoc, Budulan and Mincy, have poikilitic matrix textures exactly like igneous rocks [illegible]

J. Geophys. Res., B, Paper 4B5631.

6560 (Meteorites)
PENECONTEMPORANEOUS METAMORPHISM, FRAGMENTATION, AND REASSEMBLY OF ORDINARY CHONDRITE PARENT BODIES
R.E. Grimm (Dept. of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA, 02139)

The occurrence and proportions of petrologic types among ordinary chondrites [illegible]

J. Geophys. Res., B, Paper 4B5832.

6560 Planetology (Meteoritics)
MAGNETITE MORPHOLOGIES IN THE ESSEBI AND HARIPURA CM CHONDRITES
K. Hyman (Department of Chemistry, Texas A&M University, College Station, Texas, 77843), K. R. Ledger (Department of Geology, Stephen F. Austin State University, Nacogdoches, Texas, 75962) and M. W. Rowe

[illegible]

J. Geophys. Res., B, Paper 4B5815.

6570 Surface of Moon
APOLLO 14 MARE BASALTS: PETROLOGY AND GEOCHEMISTRY OF CLASTS FROM CONSORTIUM BRECCIA 14321
J.W. Shervais, L.A. Taylor (Dept. of Geol. Sci., Univ. of Tenn., Knoxville, Tn 37996), M.M. Lindstrom

[illegible]

J. Geophys. Res., B, Paper 4B5816.

6570 Surface of Moon
LUNAR LUMINESCENCE AND THE FILLING-IN OF FRAUNHOFER LINES IN MOONLIGHT
A.E. Potter (NASA, Johnson Space Center, Houston, Texas 77058), W. Mendell and T. Morgan

The filling-in of Fraunhofer lines in moonlight has been attributed to lunar luminescence. In order to test mechanisms proposed for this effect, measurements were made of the filling-in of the Na I line, the Ca I line, the Mg B doublet, and a number of lines near the doublet. The degree of filling-in was not correlated with wavelength in a way expected from a broad-band luminescence, such as thermoluminescence. However, it was correlated with equivalent width of the Fraunhofer line, such that it increased as equivalent width decreased. This suggests that the Fraunhofer line filling at the Moon's surface is caused by inelastic scattering of sunlight with a small wavelength shift, as for example, Brillouin scattering. (Luminescence, Fraunhofer lines, Brillouin scattering).

J. Geophys. Res., B, Paper 4B5416.

6570 Surface of Moon
PRISTINE HIGHLAND CLASTS IN CONSORTIUM BRECCIA 14305: PETROLOGY AND GEOCHEMISTRY
J. W. Shervais, L. A. Taylor (Dept. of Geol. Sci., Univ. of Tenn., Knoxville, TN 37996), J.C. Laul and M.R. Smith

The Apollo 14 site continues to provide pristine non mare rocks that contrast sharply with those from Apollo 16, the archetypical highland site. [illegible]

J. Geophys. Res., B, Paper 4B5817.

6570 Surface of Moon
STRATIGRAPHY AND GEOCHEMISTRY OF THE STONE MOUNTAIN CORE (64001/2)
R. V. Korotev (Department of Earth & Planetary Sciences, Washington University, St. Louis, MO 63130), R. V. Morris, and R. F. Lauer, Jr.

The double drive tube core 64001/2 collected on Stone Mountain, station 4, Apollo 16 [illegible]

J. Geophys. Res., B, Paper 4B5834.

6575 Planetology (Surface of planets)
GLOBAL MAP OF EOLIAN FEATURES ON MARS
A. W. Ward, K. B. Doyle, P. J. Helm, M. K. Weisman, and N. E. Witbeck, U.S. Geological Survey, Flagstaff, Arizona 86001

[illegible]

J. Geophys. Res., B, Paper 4B1215.

6599 General (Collision Process of Planetesimals)
LABORATORY SIMULATION OF PLANETESIMAL COLLISION II — EJECTA VELOCITY DISTRIBUTION —
T. Waza (Geophysical Institute, Faculty of Science, University of Tokyo, Tokyo 113, Japan), T. Matsui and K. Kani

Velocity distributions of fragments produced by low velocity impact against rock were obtained from high frame-rate photographs. [illegible]

J. Geophys. Res., B, Paper 4B1156.

6599 General (Io Plasma Torus)
PLASMA CONDITIONS INSIDE IO'S ORBIT: VOYAGER MEASUREMENTS
F. Bagenal (Physics Department, Imperial College, London SW7 2BZ, England)

The Voyager 1 ion data that were obtained inside the orbit of Io allow [illegible] transport of plasma from a source near Io. [illegible]

J. Geophys. Res., A, Paper 4A0454.

Solar Physics, Astrophysics, and Astronomy

7710 Corona
OBSERVATION OF A CORONAL TRANSIENT FROM 1.2 TO 6 SOLAR RADII
R.M.E. Illing and A.J. Hundhausen (High Altitude Observatory, NCAR, P.O. Box 3000, Boulder, CO 80307)

[illegible]

J. Geophys. Res., A, Paper 4A0826.

7725
SHOCK FORMATION TIME AND THE VIABILITY OF PROMPT NEW PROTON ACCELERATION IN SOLAR FLARES
D.F. Smith (Berkeley Research Associates, [illegible]) and S.H. Brecht

[illegible]

J. Geophys. Res., A, Paper 4A8131.

Tectonophysics

8110 Convection Currents
ON THE SENSITIVITY OF PARAMETERIZED CONVECTION TO THE RATE OF DECAY OF INTERNAL HEAT SOURCES
Michael J. Jackson, Henry N. Pollack (Department of Geological Sciences, University of Michigan, Ann Arbor, Michigan 48109)

[illegible]

J. Geophys. Res., B, Paper 4B5812.

8120 General or miscellaneous
MECHANICS OF CRITICAL COULOMB WEDGES: AN EXACT SOLUTION
F.A. Dahlen (Department of Geological and Geophysical Sciences, Princeton University, Princeton, New Jersey 08544)

Active fold-and-thrust belts or submarine accretionary complexes can be modelled as critically tapered wedges [illegible]

J. Geophys. Res., B, Paper 4B0880.

8155 Tectonophysics
[illegible]

J. Geophys. Res., B, Paper 4B1169.

8130 Heat Flow
HEAT FLOW IN THE BALEARIC AND TYRRHENIAN BASINS, WESTERN MEDITERRANEAN
I.Hutchison (BP Exploration, Britannic House, Moor Lane, London EC2Y 9BU), R.P.Von Herzen, K.E.Louden, J.G.Sclater and J.Jemsek

[illegible]

J. Geophys. Res., B, Paper 4B1102.

8130 Heat flow
ON THE THERMAL EFFECTS OF THREE-DIMENSIONAL GROUNDWATER FLOW
A.D. Woodbury, L. Smith (Department of Geological Sciences, University of British Columbia, Vancouver, British Columbia, Canada V6T 2B4)

[illegible]

J. Geophys. Res., B, Paper 4B1161.

8150 Tectonophysics (Plate Tectonics)
THREE DIMENSIONAL FLOW BENEATH A SLOW SPREADING RIDGE AXIS: A DYNAMIC CONTRIBUTION TO THE DEEPENING OF THE MEDIAN VALLEY TOWARD FRACTURE ZONES
E.M. Parmentier and D.W. Forsyth (Dept. of Geological Sciences, Brown University, Providence, RI 02912)

[illegible]

J. Geophys. Res., B, Paper 4B1187.

8150 Plate Tectonics
TRUE POLAR WANDER AND PLATE DRIVING FORCES
[illegible] (Lamont-Doherty Geological Observatory of Columbia University, Palisades, NY 10964) and Sean C. Solomon

[illegible]

J. Geophys. Res., B, Paper 4B1191.

8150 Tectonophysics
Geophysical investigation of a suture zone: the Border Ranges Fault of Southern Alaska
M.A. Fisher (U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California, 94025) and R. von Huene

The Border Ranges fault separates structurally complex accreted rocks from less-deformed late Paleozoic and younger rocks in the Cook-Shelikof basin. Of the five types of geophysical data used to investigate this fault, gravity data give the clearest indication of its presence and crustal structure. For at least 400 km along the fault, gravity anomalies include a +20 to +30 mGal peak along the upper plate and a -40 mGal trough along the lower plate. This paired anomaly can be modeled satisfactorily by a simple step, in a deep dense layer, that lies within 3 km of the projected offshore location of the fault. Relatively low-density rocks lie within the fault's lower plate to a depth of about 10 km, and the upper part of the fault dips within 20° of vertical. Satellite-altimetry data show that two circular geoid lows lie along the Border Ranges fault and coincide with lows in free-air gravity data. Seismic-refraction and seismic-reflection data suggest that the large-scale density anomalies that cause both types of lows must lie at depths greater that about 1 km within the margin. Three regional magnetic anomalies terminate at the fault, suggesting that it truncates obliquely rocks that lie within the Cook-Shelikof basin. Six seismic-reflection lines cross the fault, but none of them shows reflections from it. The absence of such reflections probably results from the fault's steep dip and from the presence of strong water-bottom multiples in the data. From the Late Jurassic until the early Late Cretaceous, the magmatic arc near the Cook-Shelikof basin was inactive, and we infer that the predominant motion along the Border Ranges fault was strike-slip. Resurgent Late Cretaceous magmatism was contemporaneous with uplift of rocks along the northwest side of the Border Ranges fault and with deformation of turbidite sequences in the fault's lower plate. We propose that during the Late Cretaceous, motion along the fault changed from strike slip to reverse. Cenozoic rocks near the fault show no evidence for post-Cretaceous fault movement.

J. Geophys. Res., B, Paper 4B0954.

8150 Plate tectonics
PALEOMAGNETIC EULER POLES AND THE APPARENT POLAR WANDER AND ABSOLUTE MOTION OF NORTH AMERICA SINCE THE CARBONIFEROUS
Richard G. Gordon (Department of Geological Sciences, Northwestern University, Evanston, Illinois 60201), Allan Cox, and W. Scott O'Hare

The apparent polar wander (APW) path for a plate is determined from paleomagnetic data by plotting a time sequence of paleomagnetic poles, each representing the location of the earth's spin axis as seen from the plate. APW paths consist of long, gently curved segments termed tracks linked by short segments with sharp curvature termed cusps. The tracks correspond to time intervals when the direction of plate motion was constant, and the cusps correspond to time intervals when the direction of plate motion was changing. APW tracks, which mark the motion of a plate with respect the earth's spin axis, tend to lie along small circles. The center of an APW small circle track is called a paleomagnetic Euler pole (PEP). A Jurassic-Cretaceous PEP for North America was determined from 13 paleomagnetic poles. Morgan's hot spot Euler pole for 200-90 Ma lies only 15° outside the 95% confidence ellipsoid of the PEP. The good but not perfect agreement reflects displacement between the hot spot and paleomagnetic reference frames at an average rate that is smaller by an order of magnitude than the rate at which the faster plates are moving. The angular velocity of North America about the Jurassic-Cretaceous PEP was determined by plotting the angular positions of paleomagnetic poles along the track as a function of age. During the Jurassic the angular velocity was high, the corresponding RMS velocity for North America being 74 km/m.y. and the direction of absolute motion being toward the northwest. A Carboniferous-Permian-Triassic PEP was determined from 26 paleomagnetic poles. The progression of poles along this track is consistent with known ages and stratigraphy, except for systematic differences between Triassic poles from sites on and off the Colorado Plateau. These differences could be due to a small clockwise rotation of the Colorado Plateau with respect to cratonal North America, or to miscorrelations between Triassic rocks on and off the Plateau, or to large lag times between the deposition and magnetization of some rock units, or to some combination of these. Despite this ambiguity, the pattern of Carboniferous through Triassic APW and plate motion is clear: The RMS velocity of North America was slow (20 km/m.y.) during the Permian and Carboniferous, but rapid (60-100 km/m.y.) during the Triassic. At the cusp between the Carboniferous-Permian-Triassic track and the Jurassic-Cretaceous track, the trend of the path changes by 160°. The western point of the cusp, which is delineated by poles from the Chinle, Wingate, and Kayenta formations, is 13° farther west in our analysis than in commonly accepted APW paths for North America. An implication for terrane analysis is that northward displacements found by using our Late Triassic and Early Jurassic poles are up to 2000 km smaller than are those found by using previously published Late Triassic and Early Jurassic cratonal poles.

Tectonics, Paper 4T0561

8150 (Plate Tectonics)
RELATIVE MOTIONS BETWEEN OCEANIC PLATES OF THE PACIFIC BASIN
D.C. Engebretson, A. Cox (Dept. of Geophysics, Stanford University, Stanford, CA 94305), and R.G. Gordon

Relative motion poles describing the displacement histories between the Pacific plate and once adjacent oceanic plates (Farallon, Kula, Izanagi I, Izanagi II, and Phoenix) were derived for the late Mesozoic and Cenozoic Eras. Because fracture zone and magnetic anomaly data are generally available from the Pacific plate but not from adjacent plates, a new method of analysis for one-sided data was required. This analysis produced stage poles and rates of relative plate motion and estimates of their confidence regions. The following are the main conclusions drawn from our analysis. (1) For time intervals of the order of 10^7 years, termed stages, relative motion poles for plate pairs remained nearly fixed. Between stages, shifts in poles were commonly both large and abrupt. Within stages, rates of plate motion were commonly observed to change markedly, indicating that plates changed speed more frequently than they changed direction. (2) The relative motions of all of the plates analyzed changed at about chron M11 (135 Ma), chron 34 (85 Ma), and chron 25 (56 Ma). (3) During the Early Cretaceous there were five oceanic plates in the Pacific basin rather than the four recognized by previous workers. (4) To determine the number of Farallon plates that existed to the east of the Pacific plate during the time interval from chron 34 (85 Ma) to chron 25 (56 Ma), fracture zones and magnetic anomalies that record Pacific-Farallon spreading from the northern, central and southern Pacific plate were analyzed separately and collectively. The analysis shows that a single Pacific-Farallon relative motion pole and a single rate are consistent with all of the data. (5) Spreading rates along the Pacific-Kula ridge decreased markedly between chrons 32b and 25 (72 to 56 Ma), probably in response to the arrival of buoyant Kula lithosphere at a subduction zone northwest of the Bering Sea. (6) Soon after chron 25 (56 Ma), a major reorganization is recorded along the Pacific-Farallon boundary. The Kula-Farallon boundary is also thought to have changed during this reorganization. (7) Kula-Pacific anomalies north of anomaly 25 are modeled by assuming continued Kula-Pacific spreading after chron 25 (56 Ma). (8) Probably by chron 18 (43 Ma), Pacific-Kula spreading had ceased and the Kula-Farallon ridge system had evolved into alignment with the Pacific-Farallon spreading direction. However, the timing of these events is uncertain because Pacific-Kula data younger than chron 25 (56 Ma) are sparse. (Farallon plate, Kula plate, Izanagi plate, Euler pole)

J. Geophys. Res., B, Paper 4B1055.

8150 Plate Tectonics
INTRAPLATE SEISMICITY AND STRESSES IN YOUNG OCEANIC LITHOSPHERE
Douglas A. Wiens (Department of Geological Sciences, Northwestern University, Evanston, Illinois, 60201), Seth Stein

Focal mechanisms determined for 26 earthquakes using first motions, body wave modeling and surface wave amplitude radiation patterns, along with 13 previously determined mechanisms, indicate a diversity of faulting styles and stress orientations in oceanic lithosphere younger than 35 Ma. There is no evidence for a world-wide transition from extension to compression at a specific lithospheric age. Tensional axes of normal faulting events are oriented oblique to the spreading direction and do not show extension in the spreading direction. Compressional axes of thrust events show a weak preferred orientation in the spreading direction, presumably due to ridge push stresses. However, stress axes of thrust events in lithosphere younger than 9 Ma do not show a correlation with the spreading direction, suggesting that the ridge push force is small near the ridge. These observations indicate that tensional stress in the spreading direction is concentrated in a very narrow zone at the ridge axis, in agreement with models which assume that the axial region has very little tensile strength. Normal faulting events occur at greater depths and temperatures than thrust events, possibly because rocks under tensional stress have strength maxima at higher temperatures. Alternatively, the depths of the normal faulting events may be a result of the higher thermal gradients at depth in young lithosphere, if thermoelastic stresses are important in generating this seismicity. High seismicity rates in young lithosphere, noted previously on a global scale, seem characteristic of all three major ocean basins. However, most of the events and more than 97 percent of the total moment release of near-ridge intraplate seismicity are contained in five areas. Two zones in the Indian Ocean, one near Chagos Bank and the other in the Amsterdam-St. Paul region, indicate tension parallel to the trend of the plate boundary. A region of high seismicity near the East Pacific Rise between 3° and 7°S shows both normal and thrust faulting, while another region, on the Cocos plate west of the Panama Fracture Zone, is characterized by strike-slip faulting. Thrust, strike-slip, and normal faulting events are found in a small seismically active zone of the South-Central Pacific. The extremely uneven distribution of seismicity, if not a result of the relatively short time period studied (20 years), indicates local perturbations strongly affect near-ridge seismicity. (Intraplate seismicity, stress, oceanic lithosphere)

J. Geophys. Res., B, Paper 4B1093.

8170 Structure of the Lithosphere
GEOPHYSICAL INVESTIGATION OF A SUTURE ZONE: THE BORDER RANGES FAULT OF SOUTHERN ALASKA
Michael A. Fisher (U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025) Roland von Huene

The Border Ranges fault separates structurally complex accreted Cretaceous rocks from less deformed middle or late Paleozoic and younger rocks in the Cook-Shelikof basin. Of the five types of geophysical data used to investigate this fault, gravity data give the clearest indication of its presence and crustal structure. For at least 400 km along the fault, gravity anomalies include a +20 to +30 mGal peak along the fault's upper plate and a -40 mGal trough along the lower plate. The paired anomaly can be modeled satisfactorily by a simple step, in a deep dense layer, that lies within 3 km of the projected offshore location of the fault. Relatively low-density rocks lie along the fault's lower plate to a depth of about 10 km, and the upper part of the fault dips within 20° of vertical. Satellite altimetry data show that two circular geoid lows lie along the Border Ranges fault and coincide with lows in free air gravity data. Seismic refraction and seismic reflection data suggest that the large-scale density anomalies that cause both types of lows must lie at depths greater than about 1 km within the margin. Three regional magnetic anomalies (Knik Arm, Seldovia, and Shelikof) terminate at the Border Ranges fault, suggesting that the fault truncates rocks that lie along its northwest side. Six seismic reflection lines cross the Border Ranges fault, but none of them shows reflections from it. The absence of such reflections probably results from the fault's steep dip and from the presence of strong water bottom multiples in the data. From the Late Jurassic until the early Late Cretaceous, the magmatic arc near the Cook-Shelikof basin was inactive, and we infer that the predominant motion along the Border Ranges fault was strike slip. Resurgent late Cretaceous magmatism was contemporaneous with uplift of rocks along the northwest side of the Border Ranges fault and with deformation of turbidite sequences in the fault's lower plate. We propose that during the Late Cretaceous, motion along the Border Ranges changed from strike slip to reverse. Cenozoic rocks near the fault show no evidence for post-Cretaceous fault movement.

J. Geophys. Res., B, Paper 4B0954.

8170 Structure of the lithosphere (Electrical)
INHOMOGENEOUS STRUCTURE OF THE SENEGAL LITHOSPHERE [illegible] DEEP MAGNETOTELLURIC SOUNDINGS
M. Ritz (Office de la Recherche Scientifique et Technique Outre-Mer BP 1386, Dakar, Senegal)

Data from 23 magnetotelluric sites were used to determine electrical conductivities within the crust and upper mantle in Senegal (West Africa) along a profile about 600 km long. Data have been obtained in a variety of tectonic zones : the West African craton (stable since 1850 ± 250 My), the West African mobile belt (with ages in the range of 350-650 My), and the Senegal sedimentary basin. An earth model shows several heterogeneities extending deep in the lithosphere and, perhaps more deeply in the asthenosphere, to a depth of about 460 km. At the stations in the western part of the basin, the average resistivity is anomalously low (20-30 ohm-m) down to about 10 km. The basin anomaly in the upper crust is assumed to mark an initial rift zone; it may reveal a pattern of crustal weakness in this area. Beneath this zone, the resistivity is in the range of 1000-3000 ohm-m down to at least 100 km. In the eastern basin, the resistivity is decreasing in the depth range of 20-30 km and the top of the ultimate mantle conductor is at a depth of 300 km. At the sites in the marginal part of the West African craton, conductive layers can be recognized in the depth range of 30-40 km and 80-100 km. The resistivity drops to 10 ohm-m at a depth of about 460 km. The model in this region is compared with available geological and geophysical information, and an attempt is made to explain some of the observed discontinuities by plate tectonics. It is suggested that the major discontinuity which separates the basin and the mobile belt and extends to about 460 km could be interpreted as marking a Precambrian subduction slab dipping eastward. In the West African craton, a low resistivity has been determined for a depth range of 130-150 km. The upper 130 km were found to have the rather high resistivities of 1000-3000 ohm-m. A sharp rise in conductivity occurs at a depth of about 460 km beneath the craton. In contrast, a surprising feature in the Kedougou region (in the craton) is that the major portion of the lower crust is conductive. The existence of a Birrimian geosynclinal pair in eastern Senegal consisting of a eugeosynclinal marine andesitic volcanic trough, particularly volcanics with ophiolite affinity, and a miogeosynclinal sedimentary sequence could characterize a modern plate-tectonic phase dominated by widespread ocean opening and continental collision. The conductive material in the lower crust might be explained by the buried ocean crust. (West Africa, magnetotelluric, electrical conductivity, lithosphere, subduction).

J. Geophys. Res., B, Paper 4B1119.

8190 Instruments and Techniques
THE DETERMINATION OF STRESS FROM SLIP DATA: FAULTS AND FOLDS
Andrew J. Michael (Department of Geophysics, Stanford University, Stanford, California, 94305)

A new technique is derived to invert slickenside data for the stress field that caused the faulting episode. This inversion is simplified by the assumption that the magnitude of the tangential traction on the various fault planes, at the time of rupture, is similar. Study of three normal faulting regimes show that the inversion derived with this assumption yields results that closely match older inversions that did not include the assumption. Hence the assumption may be valid, and is shown to be justified by analyzing a simple fracture criterion. Application of slip data inversion is extended from faulting regimes, to the slip on bedding plane faults in folding regimes. Comparison of the inversion results with the geometry of the folds shows this application to be successful, greatly increasing the number of data sets that can be used to find the paleostress field. (Lithospheric stress, inversion, faulting, folding)

J. Geophys. Res., B, Paper 4B0986.

8199 General (Tectonophysics)
RECENT MOVEMENT ON THE GARLOCK FAULT AS SUGGESTED BY WATER-LEVEL FLUCTUATIONS IN A WELL, FREMONT VALLEY, CALIFORNIA
Diane K. Lippincott, John D. Bredehoeft (U.S. Geological Survey, Menlo Park, California, 94025), W. R. Moyle, Jr.

Water levels have been continuously recorded since March 1978 in a well in Fremont Valley, where several strands of the adjacent Garlock fault zone have exhibited both left-lateral and components of normal displacement. Differences in water levels indicate that a fault segment lies between the observation well and a nearby irrigation well. During the 4-year recording period, six sharp fluctuations, or "spikes," were noted. These fluctuations, occurring over 2- to 4-day periods, have amplitudes of 15 to 30 cm. They appear to be the result of creep events on a nearby fault. Two types of creep events are plausible: (1) normal slip on an en echelon trace of the Garlock fault less than 500 m south of the well, with the north side up relative to Fremont Valley, or (2) left-lateral slip on the same fault. Because of the nature of the fluctuations, we favor the latter interpretation. Dislocation models utilizing exponential, arctangent, and skewed cosine functions were used to analyze the water-level fluctuations, associated pressure distribution, and fault displacements. The results suggest that creep on the fault ranges from several millimeters to a centimeter for individual events. Estimates of cumulative creep for the period 1978-82 range from 20 to 50 mm, depending on the particular model employed.

J. Geophys. Res., B, Paper 4B1160.

8199 General
POROSITY OF SEDIMENTS IN ACCRETIONARY PRISMS AND SOME IMPLICATIONS FOR DEWATERING PROCESSES
C.J. Bray (Department of Geological Sciences, Cornell University, Ithaca, New York 14853), D.E. Karig

Rapid dewatering, largely through loss of porosity, is one of the most striking changes affecting deformed sediments in accretionary prisms. Analysis of porosity from sample and seismic data confirms that porosity in accretionary prisms is significantly less than that in basinal strata of similar lithology. More specifically, the porosity depth gradient increases arcward across the prism, until porosities less than 10% occur within a few kilometers of the surface. In deeper parts of the prism, dewatering and volume reduction occur not only during loss of porosity but also during dehydration and metamorphic reactions. Calculations involving volume change lead us to define a function, F, which reflects total volume reduction. The distribution of the relative intensity of dewatering within the prism can be calculated from the porosity contours and trajectories of sediment elements. An initial attempt indicates that in the toe region the rate of dewatering is accelerated at depth relative to the basinal section and may be greatest near the base of the prism. Towards the rear of the prism the maximum rate of dewatering occurs at progressively shallower depths. Several lines of evidence suggest that, in addition to gradual diffuse dewatering, localized zones of strong dewatering are associated with zones of intense shear. This model of shear dewatering, based on critical state soil mechanics, suggests that sediments adjacent to the basal decollement should be strongly dewatered. (Accretionary prisms, sediment porosity and dewatering).

J. Geophys. Res., B, Paper 4B5092.

8199 General (Time-dependent crustal hydrology)
POROSITY REDUCTION AND CRUSTAL PORE-PRESSURE DEVELOPMENT
J. Walder (Rock Physics Program, Department of Geophysics, Stanford University, Stanford, Ca., 94305) and A. Nur

The influence of porosity-reduction processes on the hydrologic characteristics of the Earth's crust is examined. We present a simple mathematical model that shows the effect of porosity reduction on pore pressure development in the crust. Pore pressure in excess of hydrostatic can be generated if porosity reduction rates are sufficiently high. Elevated pore pressure could in turn affect properties such as strength and seismic reflectivity. Indirect evidence from laboratory, theoretical, and field studies indicates that porosity reduction processes are active, or very likely to be so, in large portions of the crust. Porosity, permeability, and pore pressure in the Earth's crust may well be time-dependent, even in regions not subjected to large deviatoric stresses. (Time-dependent crustal hydrology, crustal rheology)

J. Geophys. Res., B, Paper 4B1071.

Volcanology

8599 Volcanology
ERUPTIVE HISTORY OF THE RHYOLITIC KANE SPRINGS WASH VOLCANIC CENTER, NEVADA
S. W. Novak (Geology Department, Stanford University, Stanford, California 94305)

The 19 × 13 km Kane Springs Wash caldera formed 14 Ma ago following eruption of the three youngest members of the Kane Wash Tuff. Two older [illegible] of the Kane Wash Tuff are dated 15.3 ± 0.2 and 1[illegible] ± 0.2 Ma and apparently erupted from source areas west of the exposed caldera. Volcanic eruptions from the Kane Springs Wash center began about 14 Ma ago with the extrusion of trachyte lavas now preserved north of the caldera. Member V_1 of the Kane Wash Tuff overlies the trachytes and is zoned from rhyolite to trachyte. In contrast, overlying members V_2 and V_3 are slightly peralkaline rhyolites (comendites). Eruption of these tuffs 14.1 ± 0.2 Ma ago initiated caldera collapse. Following collapse, trachyte lava indistinguishable in age from the ash-flow tuffs erupted within the caldera, forming a 5-km-diameter cumulodome whose interior portions crystallized to syenite. This magmatic resurgence formed an extrusive complex within the caldera rather than doming the cauldron block as in classic resurgent calderas. Metaluminous ferroedenite-rhyolite lavas and associated ash-flow tuffs then erupted in the "moat" surrounding the central trachyte/syenite complex. Pyroclastic deposits from the domes were covered by trachyandesite and basalt lava flows about 13.4 Ma ago. Biotite-rhyolite domes dated 13.4 ± 0.2 Ma continued to erupt in the northeastern moat. A 13.4 Ma metaluminous biotite-rhyolite dome containing vapor-phase topaz overlies the trachandesite lavas and appears to be the youngest biotite rhyolite dome. These intracaldera units filled the moat resulting in a caldera filled with its own eruptive products. Local basalt flows covered both intracaldera units and outflow sheets between 12.7 and 11.5 Ma ago, prior to Basin and Range faulting. The "dominant volume" of the system was trachytic, as trachyte lavas erupted both prior to and following caldera collapse, and trachyte inclusions occur as scoriaceous bombs at the top of member V_3. Fractionation of this trachyte magma produced the slightly peralkaline rhyolitic magma that erupted as the Kane Wash Tuff. The shift from an anhydrous mineral assemblage in the tuffs to hydrous assemblages in the later intracaldera rhyolites shows that the system was cooling and was possibly more hydrous in its late stages. Petrographic characteristics of trachyandesite lavas erupted late in the history of the center suggest that they represent basaltic magmas contaminated with silicic material. (Caldera, peralkaline rhyolite, metaluminous rhyolite).

J. Geophys. Res., B, Paper 4B0365

8599 Volcanology
FORMATION OF THE AIRA CALDERA, SOUTHERN KYUSHU, CA.22,000 EARS AGO
S. Aramaki (Earthquake Research Institute, University of Tokyo, Bunkyo-ku, Tokyo, 113)

About 22,000 years ago a series of large-scale pyroclastic eruptions produced the Aira caldera 20km x 20km wide at the northern end of Kagoshima Bay in southern Kyushu. It started with a Plinian pumice eruption (98 km^3) originating from the present site of Sakurajima volcano, 8 km south of the caldera center. After a very short pause, violent explosive ejection of the basement rock fragments and pumiceous materials occurred at the central vent, gradually changing itself to a huge eruption column rapidly collapsing to form the Ito pyroclastic flow about 300 km^3 in volume. The earliest phase produced up to 30-m-thick Kamewarizaka breccia developed along the caldera rim and charged with basement (lithic) fragments up to 2 m across. The breccia is a near-vent variety of the bottom concentration zone of lithics in the Ito deposit. Various textural features and monotonous petrologic character indicate that the main part of the Ito pyroclastic flow was emplaced by a simple, short-lived eruptive mechanism. The Aira-Tn ash, a fine-grained counterpart of the Ito pyroclastic flow, covered a wide area more than 1000km from the vent. Evacuation of more than 110 km^3 of rhyolitic magma produced a funnel-shaped collapse structure with the center of the magma chamber about 10 km deep. Like many other Japanese Quaternary calderas, the Aira caldera is considered to have formed not by a piston-cylinder type subsidence utilizing a ring fracture but by coring and high-angle slumping of the wall rocks into a funnel-shaped central vent. The outline of the caldera was strongly controlled by the faults bounding the volcano-tectonic graben forming Kagoshima Bay. (Caldera, Plinian eruption, pyroclastic flow).

J. Geophys. Res., B, Paper 4B0268

8599 Volcanology topics
GEOMETRICAL FORM OF ASEISMIC RIDGES, VOLCANOES, AND SEAMOUNTS
C.L. Angevine and D.L. Turcotte (Department of Geological Sciences, Cornell University, Ithaca, New York, 14853),
J.R. Ockendon (Mathematical Institute, University of Oxford, United Kingdom)

Many volcanic structures have a regular geometrical form that suggests a simple and universal mechanism for the growth. We suggest that the surface of these volcanic structures is a surface of constant hydraulic potential. When an eruption begins, it follows a path to the point on the surface that has the minimum hydraulic resistance. This resistance includes both the frictional resistance to the flow and the gravimetric potential associated with elevation. We determine the shape of a two-dimensional volcanic edifice formed from a line source and compare the shape with bathymetric profiles across several aseismic ocean ridges. We also compare the predicted shape of an axisymmetric volcanic edifice formed from a point source with several profiles from the Cascade Range in the western United States and with a number of volcanic islands and seamounts in the Pacific.

J. Geophys. Res., B, Paper 4B0772.

8599 Volcanology
THE GEISHA GUYOTS: MULTI-BEAM BATHYMETRY AND MORPHOMETRIC INTERPRETATION
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Multi-beam bathymetric charts at 100 fm (183m) contour interval are presented and analyzed for the 1100 km long, 120° trending Geisha chain of eight guyots and at least 13 other seamounts (>1 km height) in the northwest Pacific. The Geisha guyots are compared with 23 others swath-mapped in the North Pacific. Edifice distribution along the Geisha chain consists of clusters (200 km apart) some of which are composed of subclusters (30-50 km apart) and edifices 10-20 km from their neighbors. Two published radiometric dates (94 Ma and 102 Ma) at the southeastern and northwestern ends are consistent with rapid (14 cm/a) plate motion over a fixed hotspot. Crustal age increases southwestwards from 141 to 156 Ma along the chain. Edifice volume is small (700 - 6000 km^3, 2x10^{4}km^3 for the chain). Summit plateau depths (1420m minimum, and 1600 break depth) is nearly constant. Summit plateau areas, from 14 to 296 km^2, are the smallest for any guyot chain. Original island heights (0.5 to 1.3 km) and minimum volumes eroded (2 to 100 km^3) are estimated from the height/area relation of modern volcanic islands. Summit plateau relief (ca 100-200m) is explained by simultaneous shoreline erosion (ca. 1 km/Ma) and subsidence of thermally rejuvenated lithosphere. The guyots rise 4.5-4.9 km above the regional basement, implying an original swell height of 0.5-1 km and lithosphere thermally reset to ca. 40% of its age (at time of volcanism). Flank rift zones (FRZ) are short (10-30 km) but prominent. For all guyots and seamounts, FRZ length increases with increasing differential magmastatic pressure at base of edifice. Small seamounts may lack FRZ's, large seamounts and small guyots have FRZ's lengthening at 0.2 km/MPa, and FRZ's on large ones (above 100 MPa) lengthen at 3km/MPa. (Guyots, hotspots, mid-plate volcanism, multibeam bathymetry).

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MAGMA DRIVEN PROPAGATION OF CRACKS
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A similarity solution is derived for the two-dimensional propagation of a liquid filled crack. This solution includes both the flow problem within the crack and the fracture problem through a stress intensity factor. The results are applied to the emplacement of dikes and sills and to the migration of magma through the lithosphere. We show that for these applications the propagation of the fracture is limited by the viscosity of the magma, the fracture resistance of the elastic medium can be neglected. Limitations on propagation due to magma solidification during emplacement are also considered. As a typical example for the emplacement of a dike or sill we conclude that a magma with a viscosity of 10^2 Pa s can be injected into a crack with a length of 2 km and a width of 0.5 m in a period of 15 minutes, the velocity of fracture propagation is about 0.5 m/s. We also conclude that a propagating, liquid-filled crack is a viable mechanism for the migration of magma through the lithosphere.

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